CHAPTER 10

CONSTRUCTION DRAWINGS

The construction of any structure or facility is described by a set of related drawings that give the SEABEEs a complete sequential graphic description of each phase of the construction process. In most cases, a set of drawings shows the location of the project, boundaries, contours, and outstanding physical features of the construction site and its adjoining areas. Succeeding drawings give further graphic and printed instructions for each phase of construction.

TYPES OF CONSTRUCTION DRAWINGS

Generally, construction drawings are categorized according to their intended purpose. Some of the types commonly used in military construction are discussed in this chapter.

PRESENTATION DRAWINGS

The purpose of the PRESENTATION DRAWINGS is to present the proposed building or facility in an attractive setting in its natural surrounding at the proposed site. They often consist of perspective views complete with colors and shading. Since presentation drawings are actually used to "sell" an idea or design concept, an EA assigned to the drafting section is rarely required to develop them.

SHOP DRAWINGS

SHOP DRAWINGS are drawings, schedules, diagrams, and other related data to illustrate a material, a product, or a system for some portion of the work prepared by the construction contractor, subcontractor, manufacturer, distributor, or supplier. Product data include brochures, illustrations, performance charts, and other information by which the work will be judged. As an EA, you will be required to draft shop drawings for minor shop and field projects. You may draw shop items, such as doors, cabinets, and small portable structures (prefabricated berthing quarters, and modifications of existing buildings), or perhaps you may be drawing from portions of design drawings, specifications, or from freehand sketches given by the design engineer.

MASTER PLAN DRAWINGS

MASTER PLAN DRAWINGS are commonly used in the architectural, topographical, and construction fields. They show sufficient features to be used as guides in long-range area development. They usually contain section boundary lines, horizontal and vertical control data, acreage, locations and descriptions of existing and proposed structures, existing and proposed surfaced and unsurfaced roads and sidewalks, streams, rights-of-way and appurtenances, existing utilities, north point indicator (arrow), contour lines, and profiles. Master plan and general development drawings on existing and proposed Navy installations are maintained and constantly upgraded by the resident officer in charge of construction (ROICC) and by the public works department (PWD).

WORKING DRAWINGS

A WORKING DRAWING (also called project drawing) is any drawing that furnishes the information required by the craftsmen to manufacture a machine part or by a builder crew to erect a structure; it is prepared from a freehand sketch or a design drawing. Complete information is presented in a set of working drawings, complete enough that the user will require no further information. Project drawings include all the drawings necessary for the different SEABEE ratings to complete the project. These are the drawings that show the size, quantity, location, and relationship of the building components.

A complete set of project drawings consists of general drawings, detail drawings, assembly drawings, and always a bill of materials. GENERAL DRAWINGS consist of "plans" (views from above) and elevations (side or front views) drawn on a relatively small defined scale, such as 1/8 in. = 1 ft or 1/4 in. = 1 ft. Most of the general drawings are drawn in orthographic projections, though sometimes details may be shown in isometric or cavalier projections. A DETAIL DRAWING shows a particular item on a larger scale than that of the general drawing in which the item appears, or it may show an item too small to appear at all on a general drawing. An ASSEMBLY DRAWING is either an exterior or a sectional view of an object showing the details in the proper relationship to one another. Usually, assembly drawings are drawn to a smaller scale than are detail drawings. This procedure provides a check on the accuracy of the design and detail drawings and often discloses errors.

Depending on the space available on the drafting sheet, you may incorporate the BILL OF MATERIALS in the drawing; otherwise, you are to list it on a separate sheet. The bill of materials contains a list of the quantities, types, sizes, and units of the materials required to construct the object presented in the drawing.

In a typical military construction, working (project) drawings go through stages of review and evaluation for design and technical adequacy by NAVFACENGCOM to ensure good quality, consistency, and cost effectiveness of the design. Special terms discussed in the following paragraphs describe these stages, from the initial development of the project to the final phase of construction.

Preliminary Drawings

PRELIMINARY DRAWINGS are the initial plans for projects prepared by the designer or architects and engineers (A/E) firm during the early planning or promotional stage of the building development. They provide a means of communication between the designer and the user (customer). These drawings are NOT intended to be used for construction, but they are used for exploring design concepts, material selection, preliminary cost estimates, approval by the customer, and a basis for the preparation of finished working drawings.

You will notice that most of the design work incorporated into the preliminary drawings at the 35-percent stage of completion contain, as a minimum, the following information: site plans, architectural floor plans, elevations, building sections, preliminary finish schedule and furniture layouts, interior and exterior mechanical and electrical data, and civil and structural details. All of the preliminary project drawings scheduled for use by the SEABEEs are reviewed by the COMCBPAC or COMCBLANT, as appropriate, for construction methods or procedures, whereas preliminary contract drawings are reviewed by ROICC.

Final Drawings

FINAL DRAWINGS are 100 percent complete, signed by the contracting officer, and used forbidding purposes. This set of plans becomes official contract drawings once the contract is awarded. Final drawings are often revised to show changes made by a scope change or by a change order with the concurrence of both the contractor and contracting officer. At this stage of completion, no further functional input may be introduced into the final drawings because of time constraints. In general, final drawings, together with project specifications, cost estimates, and all of the calculations, comprise the final stages of design requirements.

Red-lined Drawings

These are the official contract drawings that you will mark up during construction to show as-built conditions. RED-LINED DRAWINGS are marked in color "red" to indicate either a minor design change or a field adjustment.

As-built Drawings

These are the original contract drawings (or sepia copies) that you will change to show the AS-BUILT conditions from the red-lined drawings. Upon completion of facilities, the construction contractor or the military construction force (NMCB) is required to provide the ROICC with as-built drawings indicating construction deviations from the contract drawings. All of the as-built marked-up prints must reflect exact as-built conditions and show all features of the project as constructed. After completion of the project, as-built marked-up prints are transmitted by the ROICC to the engineering field division (EFD).

Record Drawings

The original contract drawings, corrected according to the marked prints, provide a permanent record of as-built conditions upon completion of the instruction work on a project. The original RECORD DRAWINGS may be retained in the custody of the EFD or they may be transferred to stations with public works.

CONCEPTUAL DEFINITIVE DESIGNS

These are prepared designs or drawings defining various functional, engineering, and logistical requirements for structures and facilities needed on a repetitive basis. These drawings are intended to provide a uniform basis for planning and design. CONCEPTUAL DESIGNS commonly used in the Navy include both definitive and standard designs.

Definitive Designs

DEFINITIVE DESIGNS are drawings of typical buildings and structures you will find in NAVFAC P-272, *Definitive Designs for Naval Shore Facilities, Part 1.* These drawings contain floor plan arrangements, building sections and elevations, and utility requirements for general guidance to A/E contractors or in-house staff who prepare project drawings and specifications. Part 2 of P-272 contains advance designs of more complex facilities that may include equipment layouts, piping diagrams, electrical schematics, and other critical requirements for specific guidance in preparing project designs. Both parts, however, are used in conjunction with NAVFACENGCOM criteria manuals, handbooks, and guide specifications listed in P-34, *Engineering and Design Criteria for Navy Facilities.*

Included in the facility type of designs are single-line schematics, bubble diagrams, or graphics based on definitive drawings called FACILITY PLATES. These plates (fig. 10-1) are used to show functional relationships or building layouts, such as detailed information concerning the design of individual rooms within a specific type of facility. Facility plates may show the location of all of the equipment and furnishings within a room, the location of utilities serving the room, the location and size of doors and windows, a ceiling plan reflecting the location of lighting fixtures, and other technical design information about the room. Facility plates are used instead of the definitive design whenever the plates effectively convey the necessary design data or whenever definitive are scheduled to be revised, developed, or validated. You will find most of the facility plates within the pages of criteria or design manuals (DMs).

Standard Designs

These designs are detailed working drawings of predominantly specialized structures for unique naval facilities, such as waterfront structures, aircraft operations and maintenance facilities, ammunition storage facilities, and fleet moorings. STANDARD DESIGNS form a part of the construction documents requiring only supplemental drawings for adapting the facility to the specific site. You can modify these drawings (except for ammunition facilities) as necessary to meet on-site requirements. Ammunition and explosive design standards may NOT be modified without the approval of the Naval Facilities Engineering Command (NAVFACENGCOM). When standard designs are used for a construction project, with or without modifications, a new title block and drawing number are required. The cognizant EFD assigns these numbers.

Another source of detailed construction drawings, NOT definitive, is found in NAVFAC P-437, *Facilities Planning Guide, Vol. 1.* These facility and assembly drawings contain reproducible drawings of pre-engineered structures used to satisfy the Naval Construction Force (NCF) at advanced bases in peacetime and during contingency operations. Thus, if a facility is required to meet tactical and strategic situations, construction planners can easily and readily identify and determine specific requirements and provide support. Other useful information for SEABEE planners, such as crew size, man-hours by skill, land area, and fuel necessary to make a component, facility, or assembly operational, is contained within the guide. As an EA, you should realize the importance of becoming familiar with the contents of NAVFAC P-437.

PROJECT DRAWING PREPARATION

All NAVFACENGCOM project drawings are prepared according to DOD-STD-100. The policy and procedures for preparing and developing these drawings are outlined in the military handbook MIL-HDBK-1006/1. Project drawings must be complete, accurate, and explicit since they (together with the design specifications) form the basic ingredients used in contracts for the construction of naval facilities. EAs and in-house planners also benefit from clear and consistent project drawings, especially when revising project drawings.

POLICY AND STANDARDS

The design criteria for project drawings are set by NAVFACENGCOM. These criteria also

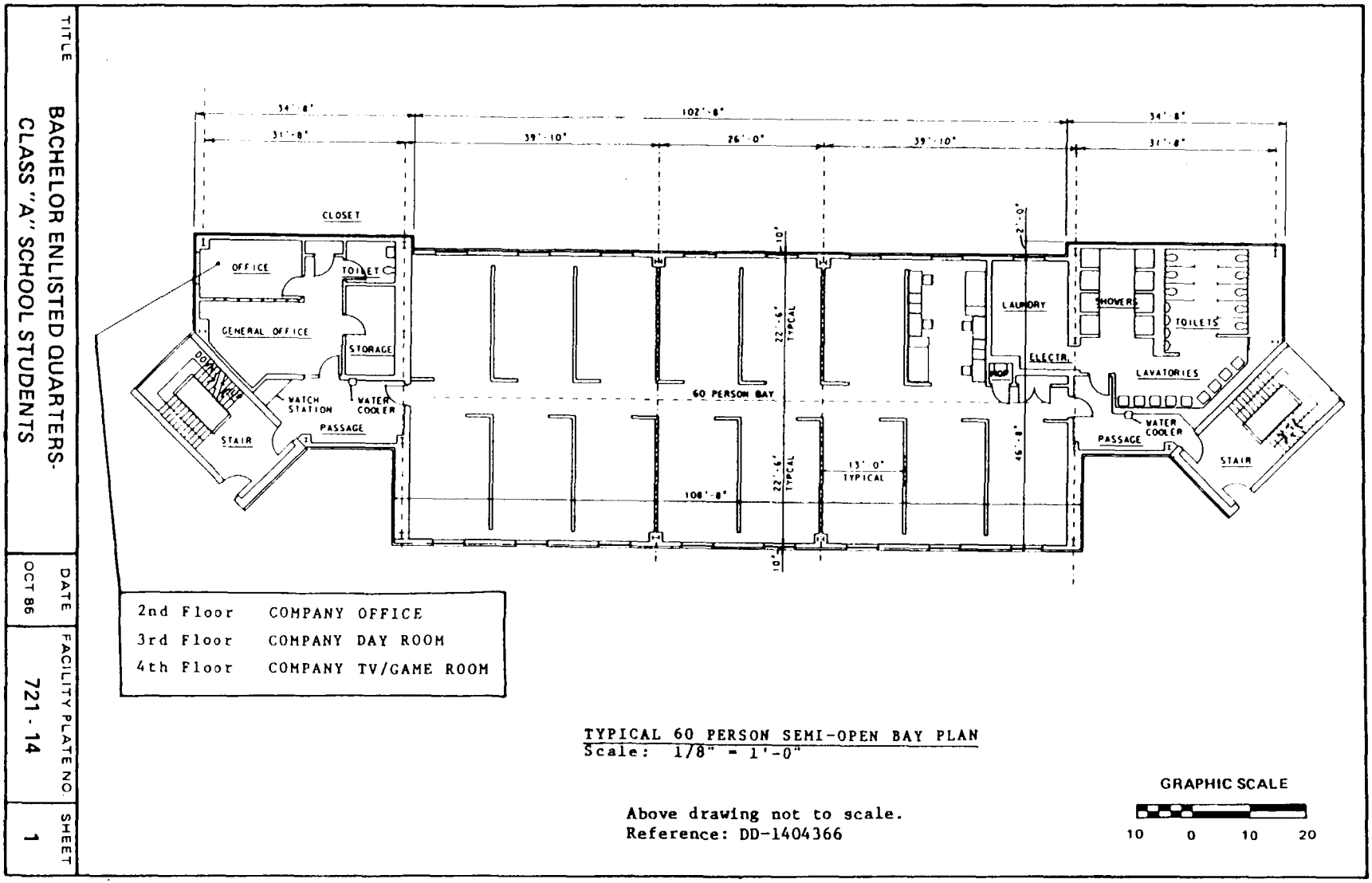

Figure 10-1.—Example of a facility plate (based on Definitive Design 1404366).

apply to definitive designs and standard drawings and also to project specifications. EFDs and A/Es are allowed latitude in new concepts, creative thinking, and the use of new materials; however, when deviations from mandatory criteria are considered, they need to obtain prior clearance from NAVFACENGCOM headquarters.

For dimensions on project drawings, you may use customary U.S. dimensions unless the project is in an area in which System International (SI) is normally used. The International System of Units is the internationally accepted "metric" system. Use of the word metric is no longer an accepted practice. For details of the proper use of SI units, refer to ASTM E380-82, *Standard for Metric Practice*, for generic conversions, and ASTM E621-79, *Recommended Practice for the Use of Metric (SI) Units in Building Design and Construction*, for conversions in engineering and design.

ORDER OF DRAWINGS

Project drawings for buildings and structures are arranged in the following order:

1. TITLE SHEET AND INDEX—Contains specific project title and an index of drawings. (Used only for projects containing 60 or more drawings).
2. PLOT OR VICINITY PLANS—Contain either plot or vicinity plans or both, as well as civil and utility plans. For small projects, this sheet should include an index of the drawings.
3. LANDSCAPE AND IRRIGATION (if applicable).
4. ARCHITECTURAL (including interior design as applicable).
5. STRUCTURAL.
6. MECHANICAL (heating, ventilation, and air conditioning).
7. PLUMBING.
8. ELECTRICAL.
9. FIRE PROTECTION.

DRAWING SHEET SIZE AND FORMAT

The following should be used for NAVFACENGCOM drawings:

TYPE	SIZE (IN INCHES)
Flat	17 x 22 (C size) - When small sheets are required
Flat	22 x 34 (D size) - for project and other drawings
Flat	28 x 40 (F size) - option to 22 x 34

Refer to chapter 3, figure 3-14 for finished drawing and format and margins.

Title Blocks

The title block indicates the name and location of the activity preparing the drawing, drawing title and number, approval within the activity and by an activity other or different than the source preparing the drawing, and other information relative to preparation of the drawing, such as the predominant scale used, drawing size letter designation, and sheet number for multiple sheet drawings. The code identification number or Federal Supply Code for Manufacturers (FSCM) "80091" is required in the title block of all NAVFACENGCOM drawings. Vertical title block format is used for all 22- by 34-in. (D-size) drawings; whereas, use of vertical title block is optional for 28- by 40-in. (F-size) drawings. The layout and format for title blocks are shown in chapter 3, figures 3-15 to 3-21, and in ANSI Y14.1-1980.

Drawing Numbers

NAVFACENGCOM drawing numbers issued to individual engineering field divisions are within the following limits:

NORTHERN DIVISION . . . . . .2 000 000 to 2 999 999

CHESAPEAKE DIVISION . . .3 000 000 to 3 999 999

ATLANTIC DIVISION . . . . . .4 000 000 to 4 999 999

SOUTHERN DIVISION . . . . . .5 000 000 to 5 999 999

WESTERN DIVISION . . . . . .6 000 000 to 6 999 999

PACIFIC DIVISION . . . . . .7 000 000 to 7 999 999

NAVFACENGCOM headquarters retains custody of all of the numbers up to and including 1 999 999 and all other drawing numbers not assigned. Each cognizant EFD is responsible for the control of assigned numbers for issuing, assigning, and recording these numbers for its own use or the use of activities within its geographical area. Each activity maintains an assignment record including locations and drawing titles of drawing numbers assigned to it.

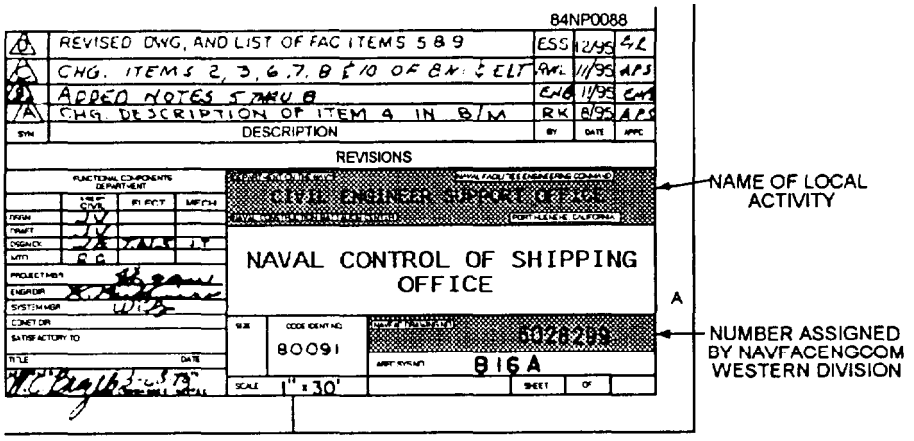

Figure 10-2.-A title block showing a drawing number assigned by NAVFACENGCOM.

(Figure 10-2 is an example of a local activity, such as the Civil Engineering Support Office (CESO), using a drawing number assigned by the Western Division (WESTDIV).)

Figure 10-2.A title block showing a drawing number assigned by NAVFACENGCOM.

You may not use a NAVFACENGCOM assigned number for any other drawing, even though the drawing to which it has been assigned is not being used. Sometimes, because of extensive revision on a particular drawing, it becomes necessary to prepare a new drawing and to assign a new NAVFACENGCOM drawing number. A cross-reference note to be placed directly above or adjacent to the title block is shown below.

Old Drawing Note:	New Drawing Note:
THIS DRAWING SUPERSEDED BY DRAWING NO. _____	THIS DRAWING SUPERSEDES DRAWING NO. _____

Drawing Revisions

Revisions to NAVFACENGCOM project drawings are to be made according to DOD-STD-100C. The revision block may include a separate "PREPARED BY" column to indicate the organization, such as an A/E firm, that prepared the revision. The layout of the modified revision block is to be as shown in chapter 3, figure 3-22, views A and B.

Graphic Scales

Graphic scales are located in the lower right-hand corner of each drawing sheet, with the words Graphic Scales directly over them. The correct graphic scales must be shown prominently on each drawing because, as drawings are reduced in size, the reductions are often NOT to scaled proportions.

Line Conventions and Lettering

You should pay close attention to the opaqueness and uniform weight of lines. To provide contrasting division and use of thick and thin lines, refer to chapter 3, figure 3-23, and ANSI Y14.2M, *Line Conventions and Lettering, Engineering Drawing and Related Documentation Practices.* Uppercase lettering is to be used except for notes on maps and similar drawings, where lowercase lettering may be used. The minimum allowable height of freehand letters is 5/32 (0.156) in., and of mechanical or computer graphics is 0.150 in. For abbreviations on drawings, use MIL-STD-12, *Abbreviations.*

DIMENSIONING AND TOLERANCING

All dimensions and tolerances are to clearly define engineering intent and be prepared according to ANSI Y14.5M, *Dimensioning and Tolerancing for Engineering Drawings.* Some of the fundamental rules that apply to dimensioning and tolerancing drawings are as follows:

1. A dimension having a tolerance may have it applied directly to the dimension or indicated by a general note on the drawing sheet.

2. Dimensioning for size, form, and location of features are to be complete; however, no more dimensions than those necessary for complete definition should be given. Neither the use of "sealing" (measuring the size of a feature directly from an engineering drawing) nor assumption of a distance or size is permitted. The use of a reference dimension on a drawing should also be minimized.

3. Dimensions should be arranged to provide optimum readability to obtain required

information. Dimensions should be selected to suit the function and should not be subject to more than one interpretation.

Detailed dimensioning format and standards will be discussed freely in this chapter to meet specific requirements. You will notice that dimensioning construction or project drawings differs in some applications from dimensioning general technical drawings. This occurs primarily because of the materials and methods of construction.

Units of Measure

As we stated earlier, the unit of measurement selected should be according to the policy of the user and the geographical area in which the project plans will be used. The U.S. linear unit commonly used on project drawings is the inch, while that of SI (metric) linear units is the millimeter. On drawings where all dimensions are either in millimeters or inches, individual linear unit identification is NOT required. However, when this is the case, your drawing should contain a note stating "UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES" (or "IN MILLIMETERS," as applicable). Millimeter dimension values shown on an inch-dimensioned drawing must be followed by the symbol mm, while inch dimension values shown on a millimeter-dimensioned drawing will be followed by the abbreviation IN.

Similarly, dimensions for angular units are expressed in either degrees and decimal parts of a degree or in degrees, minutes, and seconds. Refer to figure 10-3 for guidance, as applicable.

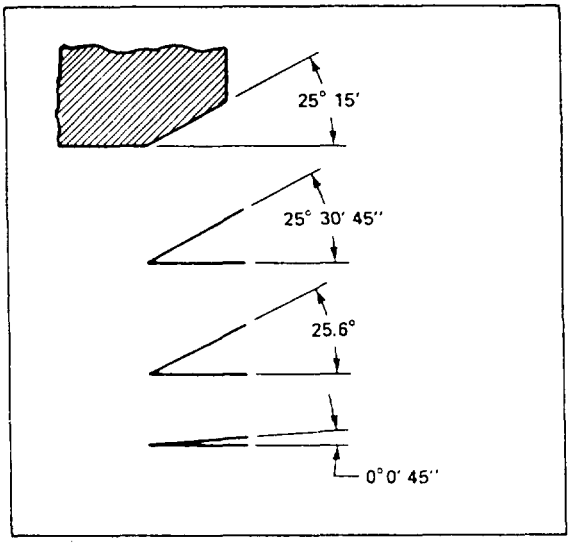

Figure 10-3.-Dimensioning angular units.

Application of Dimensions

Dimensions are applied by means of dimension lines, extension lines, or a leader from a dimension, note, or specification directed to the appropriate feature. Some of the standard rules to be followed when you are drawing DIMENSION LINES are as follows:

1. The breaking of dimension lines for insertion of numerals, as shown in figure 10-4,

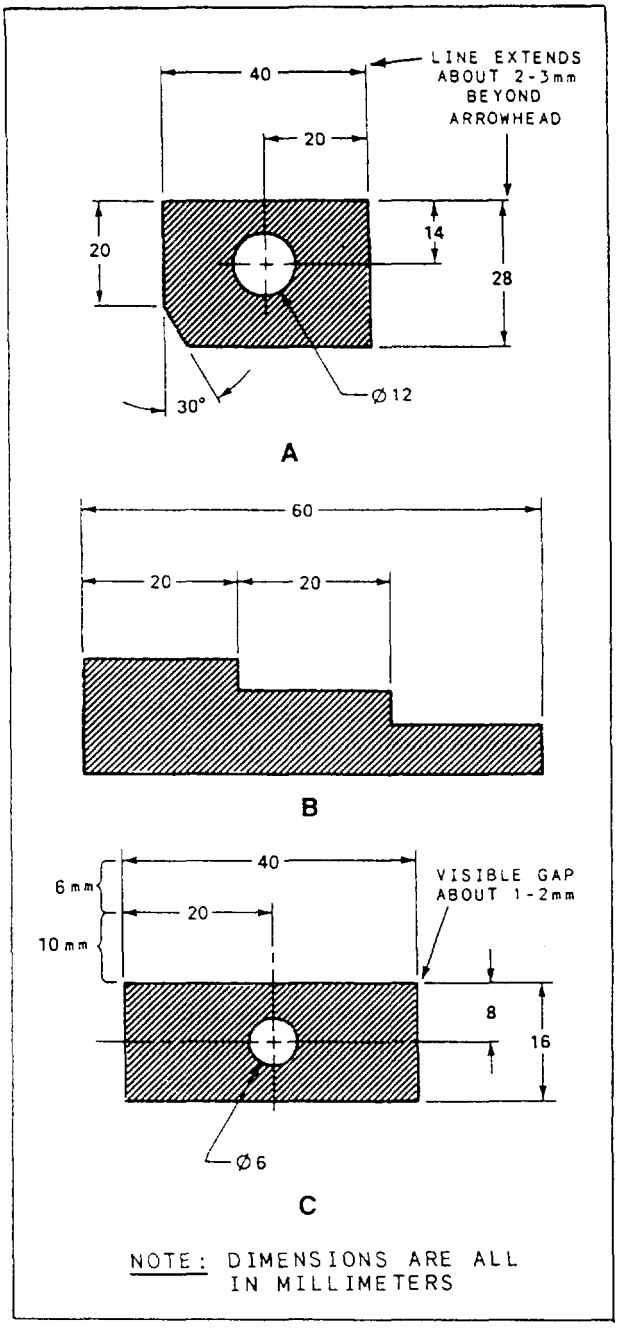

Figure 10-4.-Applications of dimensions and dimension lines: A. Breaking dimension lines for insertion of numerals; B. Grouping lines for uniform appearance; C. Proper spacing of dimension lines from object.

view A, is the preferred method of drawing dimension lines in many forms of drafting. However, for construction drawings, it is permissible, and in fact customary, to draw dimension lines from one extension line to another without breaking them. The numerals are then placed above the dimension line and parallel to the direction of measurement. This method is easier and saves considerable time.

2. Dimension lines are to be aligned if practical and grouped for uniform appearance, as shown in figure 10-4, view B. The space between the first dimension line and the object line should be not less than 10 mm, minimum; the space between succeeding parallel dimension lines should be not less than 6 mm, minimum, as shown in figure 10-4, view C. Where there are several parallel dimension lines, you may stagger the numerals for easier reading.

When using U.S. standards, you should ensure that the minimum space between the first dimension line and the object line is 3/8 in., and the succeeding parallel dimension lines are spaced at least 1/4 in. apart.

3. An angle is to be dimensioned with an arc drawn so that its center is at the apex of the angle and the arrowheads terminate at the extension of the two sides, as shown in figure 10-3.

4. Crossing dimension lines should be avoided insofar as possible. If crossing them is unavoidable, dimension lines are to be unbroken. Figure 3-23, chapter 3, shows the characteristics of dimension lines.

As explained in chapter 3, extension lines (also called projection lines) are used to indicate the extension of a surface or point to a location outside the outline of the object (or view). They are usually drawn perpendicular to dimension lines. Where space is limited, you may draw extension lines at an oblique angle. Figure 10-5, view A, clearly shows this application. You should also minimize the crossing of extension lines over one another and over dimension lines by placing the shortest dimension line closest to the outline of the object, as shown in figure 10-5, view B. Where extension lines cross arrowheads or dimension lines close to arrowheads (fig. 10-5, view C), a break in the extension line is advisable. For examples in the proper use of extension lines, refer to chapter 3, figures 3-30 and 3-31. LEADERS (or leader lines), also explained in chapter 3, direct dimensions, notes, or symbols to the intended place on the drawing.

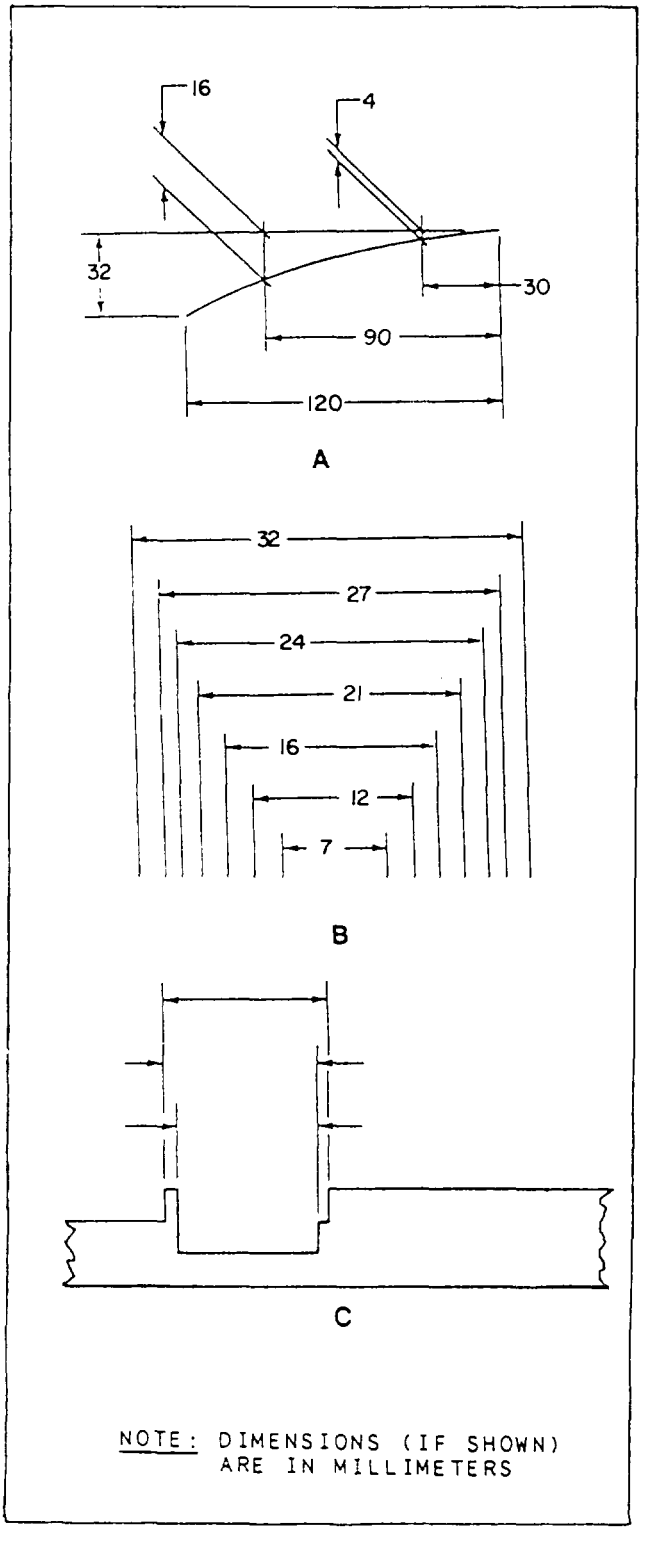

Figure 10-5.-Applications of extension lines: A. Where space is limited; B. Minimizing crossing of extension lines; C. Where extension lines break.

DRAWING SYMBOLS

Because of the small scale used in most drawings, standard graphic symbols are used to present complete information concerning construction items and materials. These typical symbols are used so frequently in construction drawings that their meanings must be familiar not only to the preparer, but to the user as well. The main information sources for a particular symbol are the Military (Drawing) Standards (MIL-STD) and the American National Standards Institute (ANSI). Refer to these standards before you use other references. Listed below are some of the most commonly used military standards and the particular symbols they carry.

Standard	Description
MIL-STD-14	Architectural Symbols (latest revision)
MIL-STD-17-1	Mechanical Symbols (latest revision)
MIL-STD-18	Structural Symbols (latest revision)
ANSI Y32.9-1972	Graphic Symbols for Electrical Wiring and Layout Diagrams Used in Architecture and Building Construction
ANSI Y32.4-1977	Graphic Symbols for Plumbing Fixtures for Diagrams Used in Architecture and Building Construction
ANSI/AWS A2.4-1986	Symbols for Welding

Sometimes you may notice that other symbols are not included in any of the standards mentioned earlier. These symbols, like the ones shown in figure 10-6, can be found in one of the military handbooks developed by NAVFACENGCOM for project drawings. As an EA, you will find that your knowledge of applicable symbols will greatly assist you in accomplishing the job correctly and promptly, and, above all, with confidence. Some of the basic architectural and welding symbols are shown in figures 10-7 through 10-10. Other types of symbols are shown in the appendix section of this book.

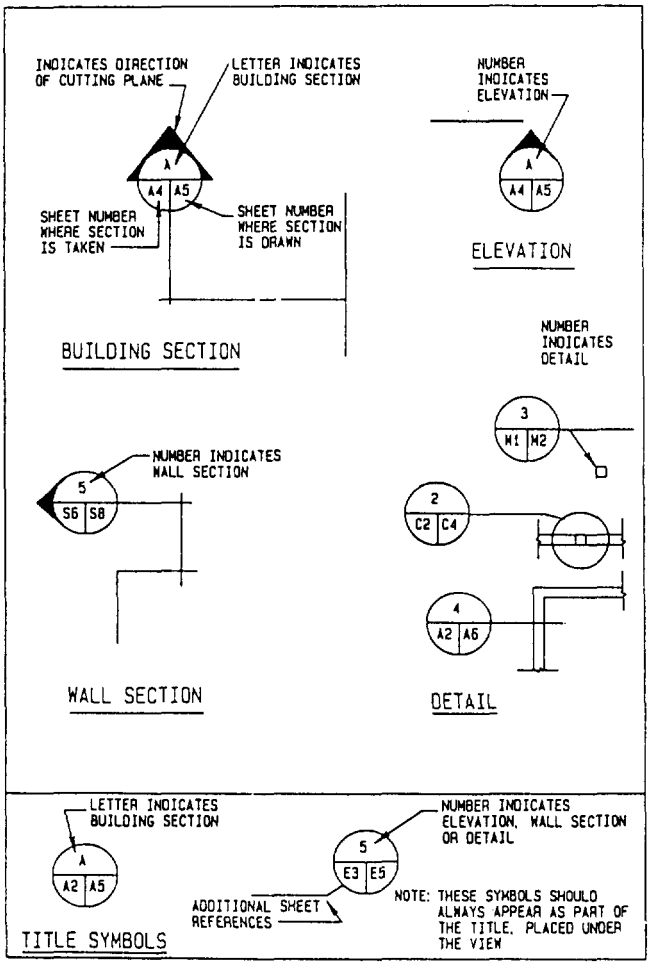

Figure 10-6.-Symbols used to identjfy sections, elevations, and details.

DRAWING NOTES

NOTES are brief, clear, and explicit statements regarding material use and finish and construction methods. Notes in a construction drawing are classified as specific and general.

SPECIFIC notes are used either to reflect dimensioning information on the drawing or to be explanatory. As a means of saving space, many of the terms used in this type of notes are often expressed as abbreviations.

GENERAL notes refer to all of the notes on the drawing not accompanied by a leader and an arrowhead. As used in this book, general notes for a set of drawings covering one particular type of work are placed on the first sheet of the set. They should be placed a minimum of 3 in. below the space provided for the revision block when the conventional horizontal title block is used. When the vertical title block is used, you may place the general notes on the right side of the drawing. General notes for architectural and structural drawings may include, when applicable,

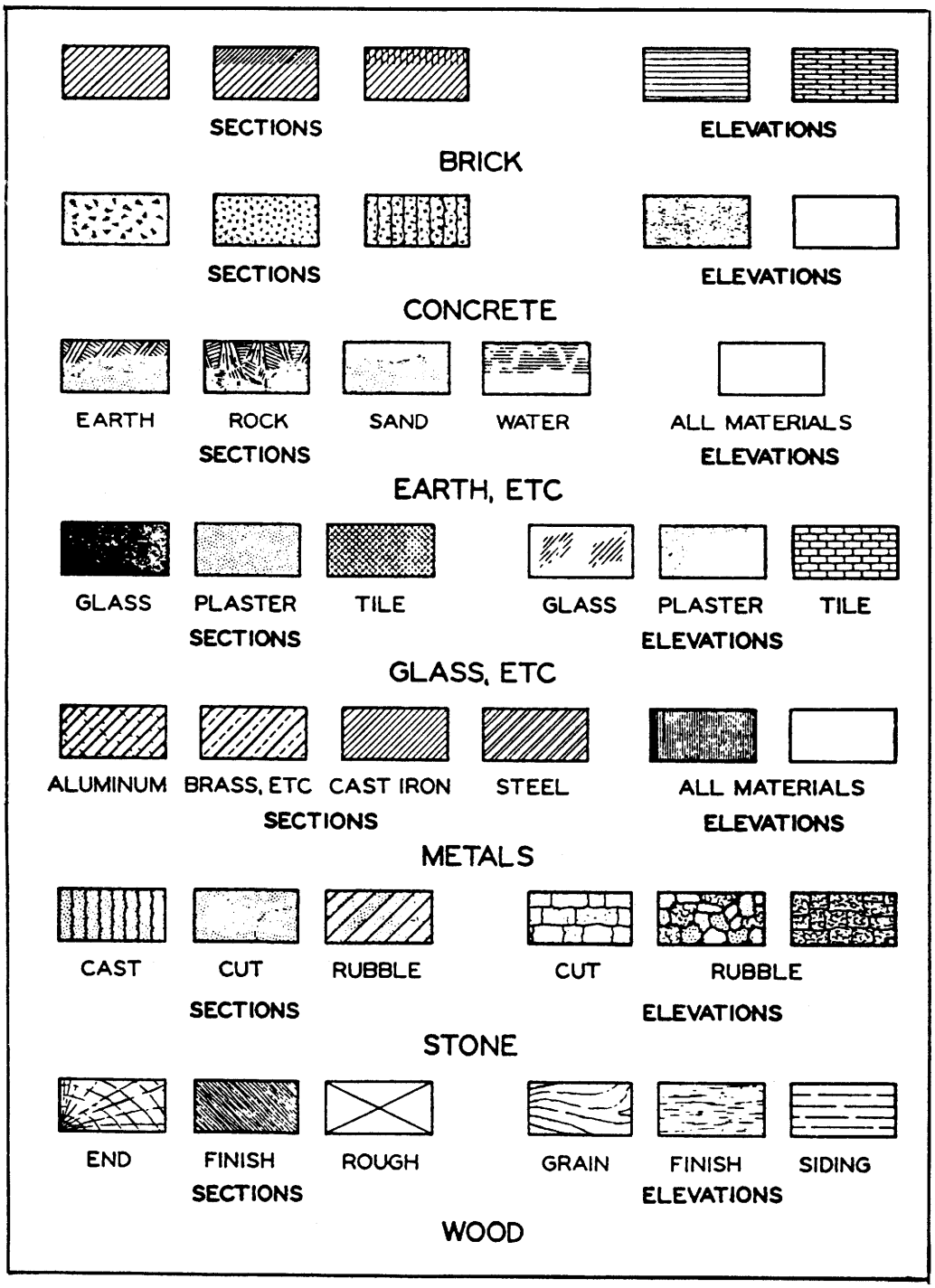

Figure 10-7.—Common architectural symbols (for various materials) used in drawing sections and elevations.

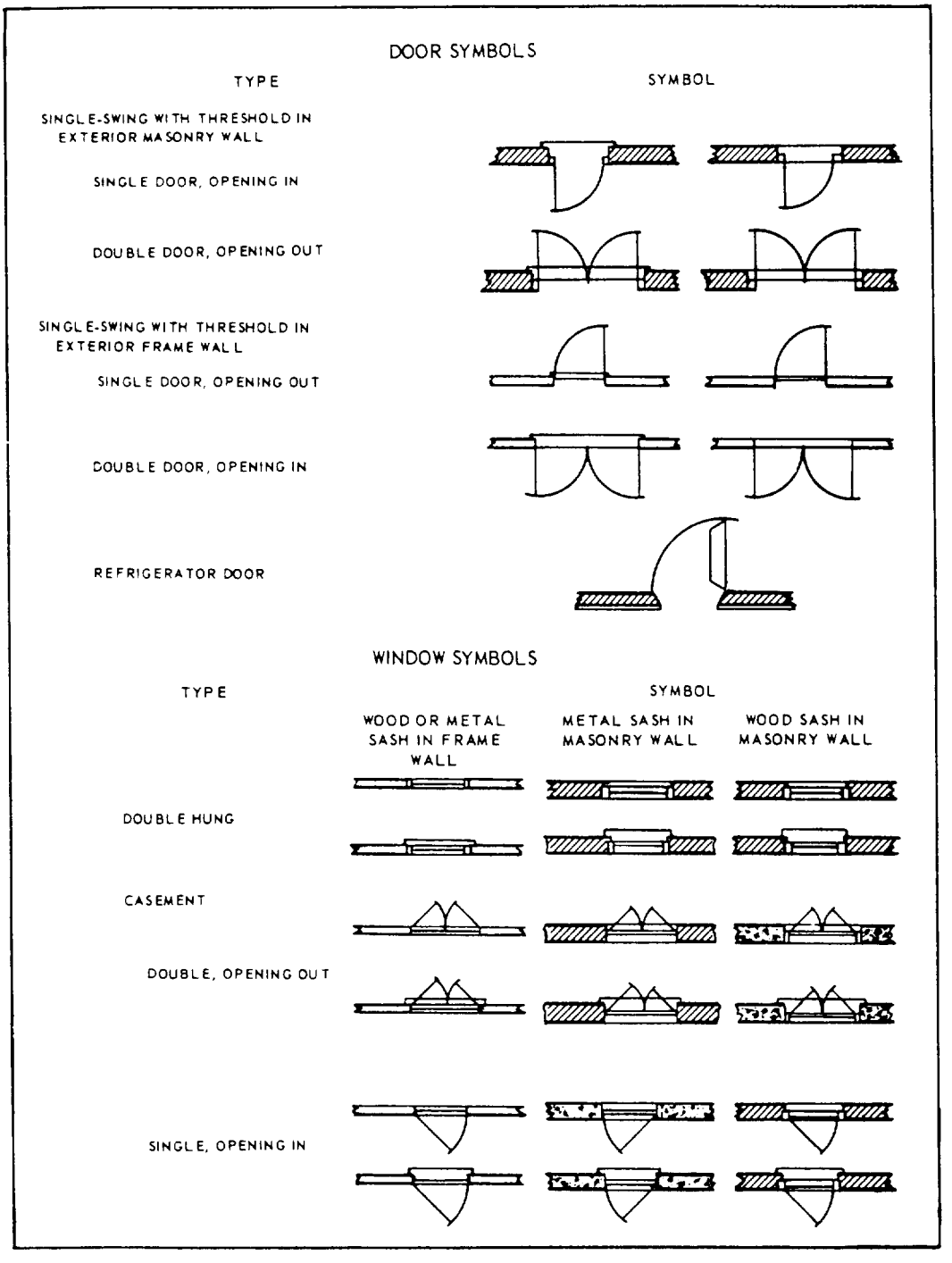

Figure 10-8.-Architectural symbols (doors and windows).

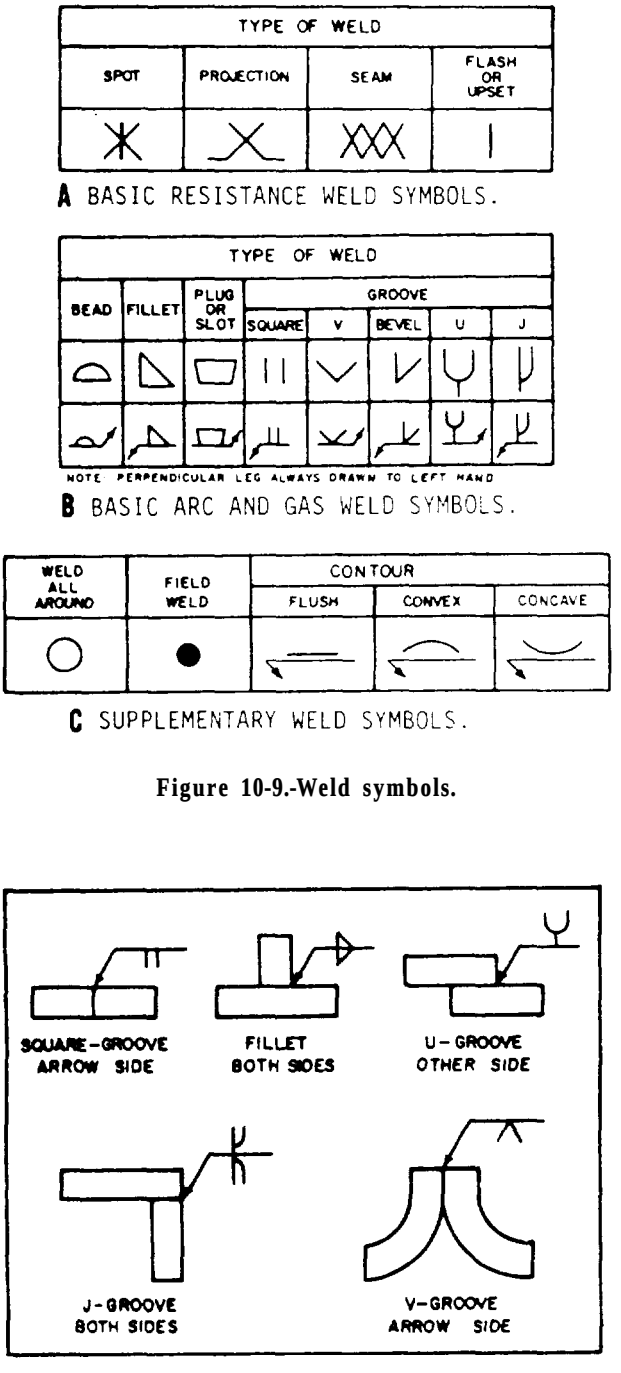

Figure 10-9.-Weld symbols.

Figure 10-10.-Application of weld symbols.

roof, floor, wind, seismic, and other loads, allowable soil pressure or pile-bearing capacity, and allowable unit stresses of all the construction materials used in the design. Notes for civil, mechanical, electrical, sanitary, plumbing, and similar drawings of a set may include, when applicable, references for vertical and horizontal control (including soundings) and basic specific design data.

General notes may also refer to all of the notes grouped according to materials of construction in a tabular form called a SCHEDULE. Schedules for items like doors, windows, rooms, and footings are somewhat more detailed. Their formats will be presented later in this chapter.

MAIN DIVISIONS OF PROJECT DRAWING

Generally, working or project drawings may be divided into the following major categories: civil, architectural, structural, mechanical, electrical, and fire protection. In SEABEE construction, however, the major categories most commonly used are as follows: CIVIL, ARCHITECTURAL, STRUCTURAL, MECHANICAL, and ELECTRICAL sets of drawings.

Regardless of the category, working drawings serve the following functions:

- They provide a basis for making material, labor, and equipment estimates before construction begins.

- They give instructions for construction, showing the sizes and locations of the various parts.

- They provide a means of coordination between the different ratings.

- They complement the specifications; one source of information is incomplete without the others.

CIVIL DRAWINGS

Civil working drawings encompass a variety of plans and information to include the following:

Site preparation and site development

Fencing

Rigid and flexible pavements for roads and walkways

Environmental pollution control

Water supply units (that is, pumps and wells)

Depending on the size of the construction project, the number of sheets in a set of civil drawings may vary from a bare minimum to several sheets of related drawings. Generally, on an average-size project, the first sheet has a location map, soil boring log, legends, and sometimes site plans and small civil detail drawings. (Soil boring tests are conducted to determine the water table of the construction site and classify the existing soil.) Civil drawings are often identified with the designating letter C on their title blocks.

A SITE PLAN (fig. 10-11) furnishes the essential data for laying out the proposed building lines. It is drawn from notes and sketches based upon a survey. It shows the contours, boundaries,

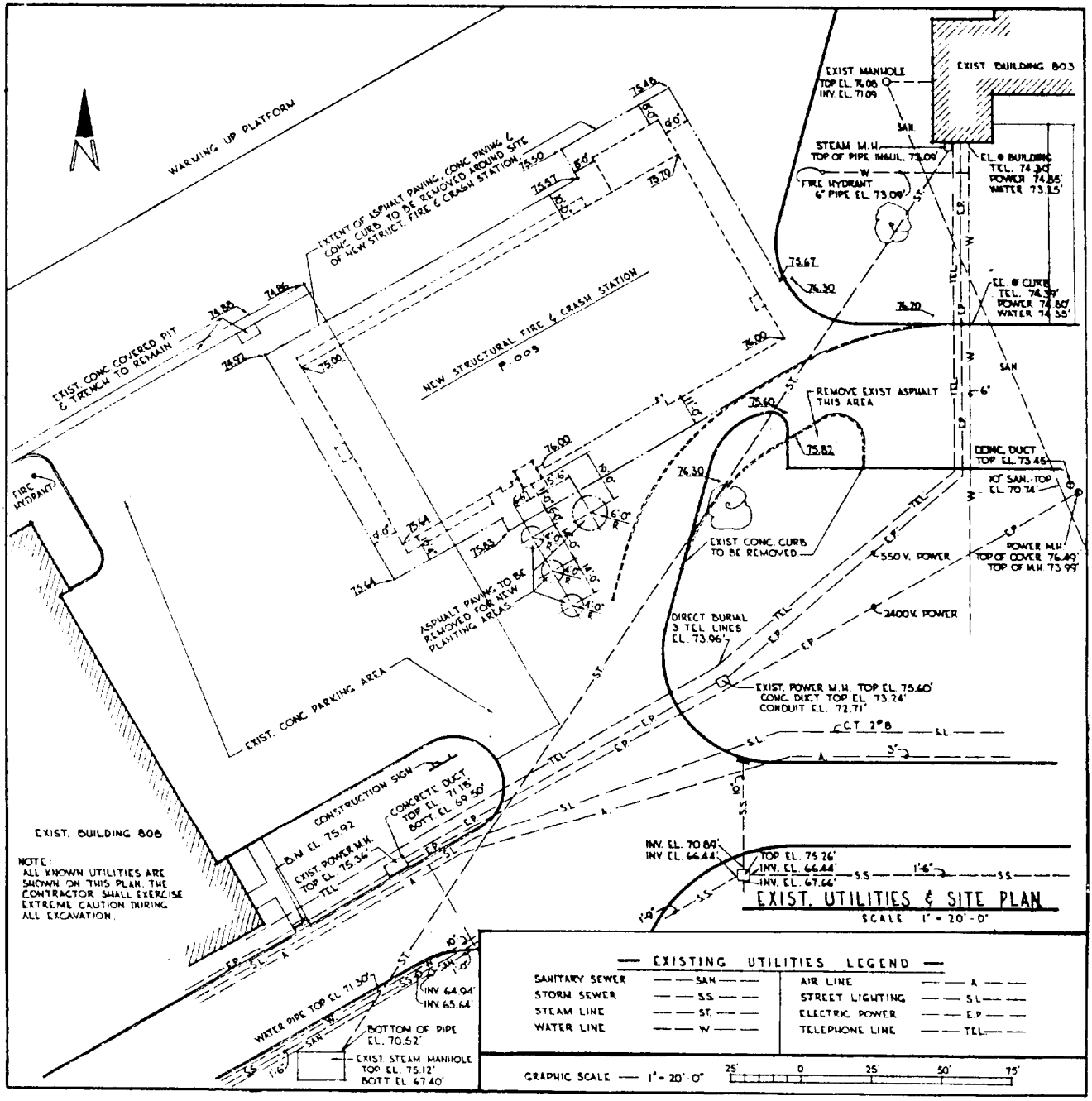

Figure 10-11.-Example of a site plan with existing utilities.

roads, utilities, trees, structures, references, and other significant physical features on or near the construction site. By showing both existing and finished contours, the field crew (Equipment Operators) is able to estimate and prepare the site for construction and to finish the site (including landscaping) upon completion of construction. As an EA, you should be familiar with the methods and symbols used on maps and topographic drawings.

Site plans are drawn to scale. In most instances, the engineer's scale is used rather than the architect's scale. For buildings on small lots, the scales normally used are 1 in. = 10 ft or 1 in. = 20 ft. This means that 1 in. on the drawing is equal to 10 or 20 ft, whichever the case may be, on the ground. Since the engineer's scale is the principal means of making scaled site plans, you, as an EA, should be thoroughly familiar with its uses.

On a set of project drawings prepared by an A/E firm, the physical information given on the site plan is taken from surveyor-prepared field notes or sketches. Other information contained on the site plan may also be used by the planners and estimators when figuring quantities of materials required, labor needed, and areas available for staging of equipment and materials.

As an EA, you may be tasked with drawing a site plan or revising one. Outlines of some of the basic procedures in the development of a site plan follow.

1. Lay out the site plan from the surveyor's drawing, showing boundary lines or limits of construction and existing trees and construction. Also note any existing features that must be removed.

2. Draw contour lines with dashed lines. Notice that if contour lines are placed on the reverse side of the drafting sheet, they make future changes or revisions easier.

3. Draw the proposed building and all surrounding construction, such as sidewalks and parking areas. Show the outline of the building wall with solid lines and the outline of the roof overhang with dashed lines.

4. Give the finished floor elevations of the building or buildings, garages (if any), and finished elevations desired on sidewalks and parking areas.

5. Review the existing contour lines. It is important that surface water not run into the buildings and other constructions, but rather towards a storm drainage system.

6. Place the dimensions. Locate the building and other constructions by a minimum of two location dimensions. If the building is not positioned parallel with the property line, more than two dimensions are required. Dimensions should be from the property line to the exterior wall of the building, not the overhang. Other dimensions necessary to be included are distances to road center lines, utility lines, easements, and any restrictions or obstructions to the site, such as utility poles and hydrants.

7. Double-check your drawing, taking a second look at the finish grade elevations, datum point, and other related information. A good technique is keeping a site plan checklist handy to make sure information given is complete and accurate.

ARCHITECTURAL DRAWINGS

ARCHITECTURAL WORKING DRAWINGS (sometimes identified with the designating letter *A* on their title blocks, as shown in chapter 3, figure 3-17) consist of all the drawings that describe the architectural design and composition of the building. A set of architectural drawings includes floor plans, building sections, exterior and interior elevations, millwork, door and window details and schedules, interior and exterior finish schedules, and special architectural treatments. For small, uncomplicated buildings, the architectural drawings might also include foundation and framing plans, which are generally included as part of the structural drawings.

Floor Plan

A FLOOR PLAN is a horizontal section through a building, showing the outline or arrangement of the floor. An offset cutting plane is often required to pass through low and high features on the wall in order to reveal doors, windows, fireplaces, stair openings, and other features located in the building.

The floor plan is usually the first drawing worked on by the EA. It is considered the key drawing in a set of project drawings—the drawing that all of the construction personnel will look at. Hence, the purpose of the floor plan is to show information about the location and type of construction, location and size of doors, windows, built-in fireplaces, stairs, rooms, and exterior and interior features.

Figure 10-12 shows the manner in which a floor plan is developed. Imagine that after the

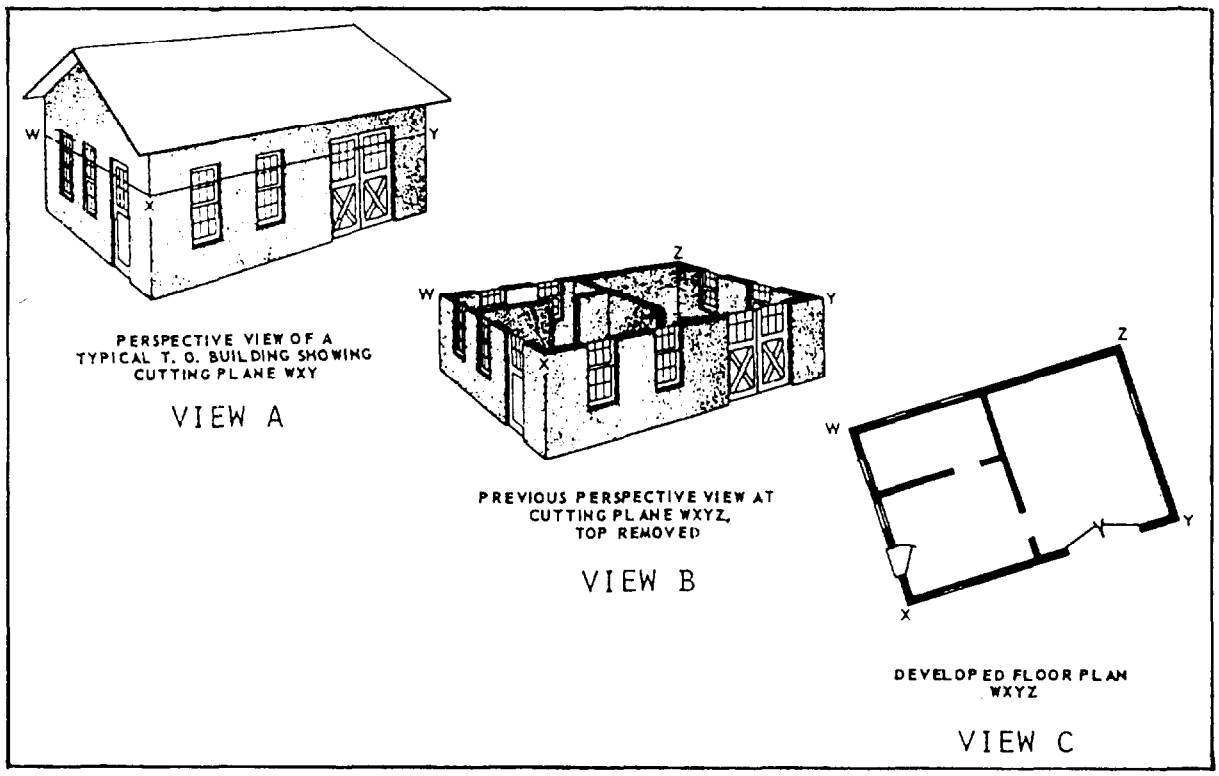

Figure 10-12.-Development of a floor plan.

building has been constructed, a cutting plane is used and cuts through the structure passing through the plane WXYZ (view A) and that the upper portion has been removed (view B). You would then be able to look down on the floor from above, and the drawing of what you see would be the floor plan (view C).

Figure 10-13 shows a floor plan of a concrete-masonry construction. It gives the lengths, thicknesses, and character of the outside walls and partitions at the particular floor level. It also shows the dimensions and arrangement of the rooms, the widths and locations of the doors and windows, and the locations and character of the rest rooms and other utility features. Study figure 10-13 carefully!

DRAWING A FLOOR PLAN.— Proper scale selection and sheet layout should be done to achieve the best results on the drawing. Before doing the actual drawing, you should draw up preliminary sketches to include the approximate size of the building, room dimensions, wall thicknesses, corridor widths, and so forth. Ideally, a scale of 1/4 in. = 1 ft should be used for easy readability. Smaller scales, such as 3/16 in. = 1 ft and 1/8 in. = 1 ft, are sometimes used for large buildings and in cases in which the size of the sheet is limited.

After you have selected the proper scale and sheet layout, you should follow the procedures outlined below.

1. Lay out construction lines (after taping the sheet to the drafting board surface) for borders, title block, and exterior limits of the building at any one side. Lay out the rooms and walls from left to right, with the exterior wall thickness being drawn first. Since the wall thickness varies with the materials used, it is impossible to accurately draw actual dimensions of each material selected. An EA would use a “nominal” wall thickness dimension of 6 in. for a wall frame exterior wall that has no brick or stone veneer. In a wall, a VENEER is a thin covering of material, such as brick, placed over a backing material of wood frame or block. Nominal wall thicknesses found in the *Architectural Graphics Standards* (AGS) should be used as a guide. Lay out the interior walls across the building,

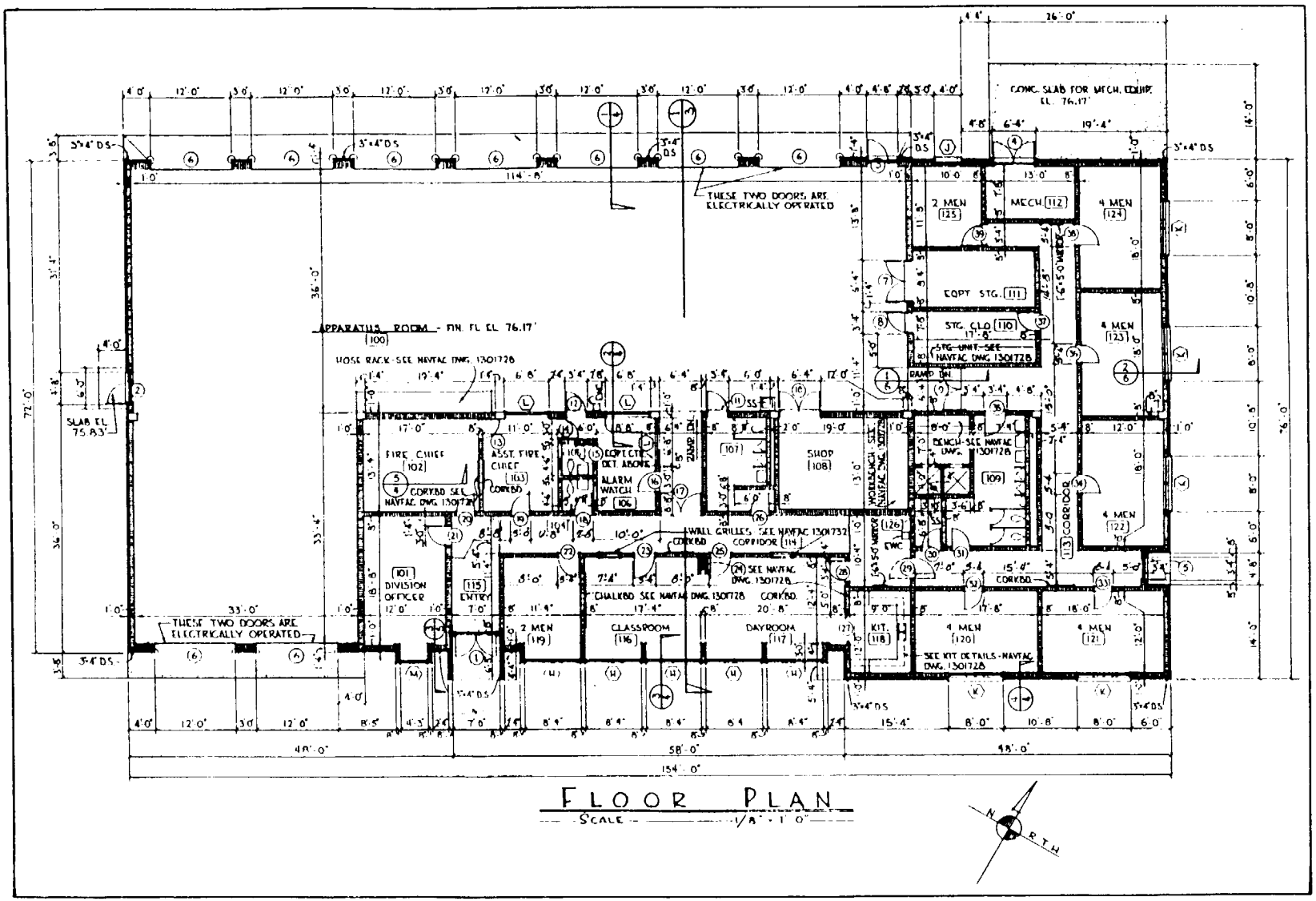

Figure 10-13.—Example of a floor plan for a concrete-masonry construction.

checking rooms, closets, bathrooms, corridors, and so on, as you proceed. Notice that a wider wall is required to allow room for a plumbing pipe to be contained within the wall.

2. Locate all doors. Both exterior and interior doors can be drawn easily if you use an architectural template. Notice that exterior doors in residential houses generally swing inward, whereas those of commercial buildings are often required by building or fire codes to swing outward. Some people prefer a full or 90-degree door swing over the 30-degree swing because they can check to be certain that it will not interfere with any equipment, walls, or appurtenances in the room.

3. Draw in and locate all windows, using proper window symbols and conventions. Next, draw the stairs (and handrails, if any) and other exterior and interior features, fixtures, equipments, appliances, and cabinets, using their proper symbols.

4. Lay out the guidelines for dimensions and the dimension lines. Now that the building basic floor plan is lightly laid out, double-check and review the accuracy and completeness of the information drawn in. You are now ready to darken in the plan. Remember that, other than the construction lines (which need not be erased), all of the lines must be drawn darkly and will vary only in the width of their lines. As an EA, you must develop a systematic approach in pursuing a fast and orderly darkening of lines. Darkening from left to right and then from top to bottom is common practice. To help keep the drawings clean, EAs often cover a partial section of their finished drawing with a clean sheet of paper while darkening the exposed section.

5. Draw in section markings on the floor plan and indicate where the wall sections have been taken. If at this point neither the section nor detail markings have been decided upon, they may be placed on the plan later. Complete the drawing by adding all the material symbols, title, graphic scale, and other relative information. Go over your floor-plan checklist for completeness.

One of your challenges as an EA (and a measure of drafting competency) is to apply your dimensioning technique to the various types of materials and construction methods used on the building. Although the principles of dimensioning and general locations of dimensions are the same, a difference exists in which dimensions are shown, and how the walls, openings, and partitions are dimensioned.

DIMENSIONING A FLOOR PLAN.— Generally, dimensions should be laid out on sketch paper before they are placed on the drawing. Besides dimensions for interior partitions, as many dimensions as possible are placed outside the plan to avoid overcrowding. Moreover, exterior dimensions are kept far enough away from the plan to avoid interfering with roof overhangs, notes, porches, or other features. In DIMENSIONING FLOOR PLANS, proceed as follows:

1. For wood-frame construction, locate the extension line of the exterior wall dimension at the outside face of the studs or stud line (fig. 10-14, view A). Partitions are measured from the

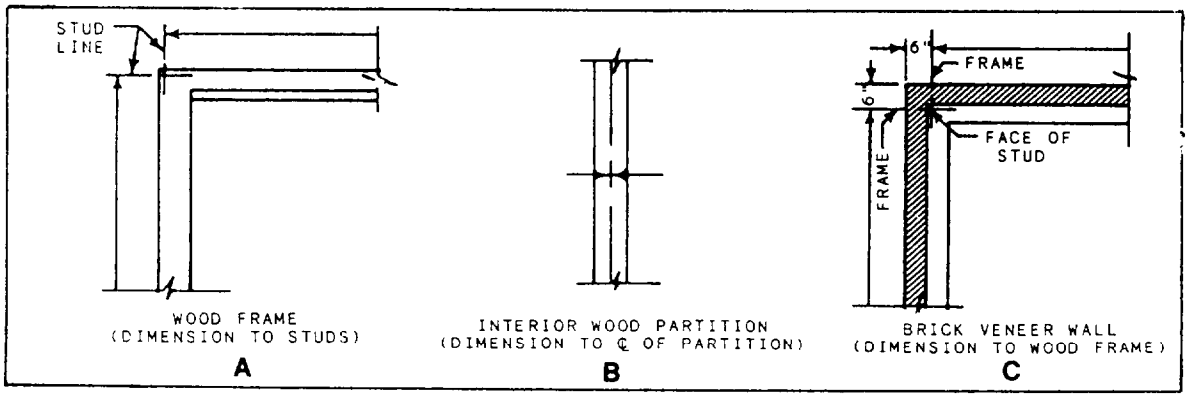

Figure 10-14.-Dimensioning wood-frame and veneer construction.

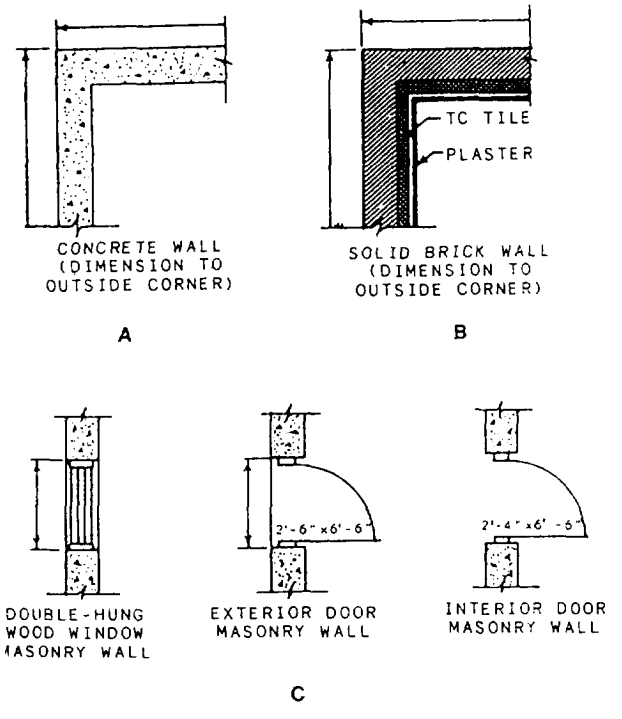

Figure 10-15.-Dimensioning concrete-masonry construction; window and door openings.

outside face of the studs to the center line of the partition (fig. 10-14, view B). In some cases, partitions are measured from the outside face of the studs to the face of the interior stud walls. The important thing is to be consistent. You must take extra care to see that all of the partition measurements are referenced from the same exterior wall. In wood frame with veneer construction, dimensioning is the same as wood frame without veneer (fig. 10-14, view C). The only difference is in the overall dimension showing the total size of the house when the veneer is added. In concrete-masonry constructions, the dimensions are all given to the face of the walls and not to the center lines, as shown in figure 10-15, views A and B.

2. In wood frame construction, doors and windows are dimensioned to their center lines. This is not the case in concrete or masonry construction, as shown in figure 10-13. Notice in this figure that the rough openings of the doors and windows and the distance between the rough openings are dimensioned. This is the correct procedure for concrete or masonry construction. Also see figure 10-15, view C, for dimensioning doors and windows in masonry construction.

3. Throughout your dimensioning of the floor plan, and then again when finished, take time to check your dimensions for legibility and accuracy. Make sure, also, that the cumulative total of all short dimensions add up to their corresponding overall dimension.

Elevations

ELEVATIONS are orthographic projections showing the finished interior and exterior appearance of the structure. Interior elevations are required for important features, such as built-in cabinets and shelves, but it is not uncommon for elevations to be drawn for all interior walls in each room of a building. Cabinet elevations show the cabinet lengths and heights, distance between base cabinets and wall cabinets, shelf arrangements, doors and direction of door swings, and materials used. Interior wall elevations show wall lengths, finished floor-to-ceiling heights, doors, windows, other openings, and types of finish materials used.

Exterior elevations show the types of materials used on the exterior, where the materials are used, the finished grade around the structure, the roof slope, the basement or foundation walls, footings, and all of the vertical dimensions.

Basically, four elevations are needed in a set of drawings to complete the exterior description: the front, the rear, and two sides of a structure, as they would appear projected on vertical planes. A typical elevation is drawn at the same scale as the floor plan, either 1/4 in. = 1 ft or 1/8 in. = 1 ft, but occasionally a smaller scale may be used because of space limitations, or a larger scale, to show more detail.

There are several methods used to identify each elevation as it relates to the floor plan. The method most commonly used by SEABEEs is to label the elevations with the same terminology used in multi-view and orthographic projection; that is, FRONT, REAR, RIGHT-SIDE, and LEFT-SIDE ELEVATIONS (fig. 10-16). On

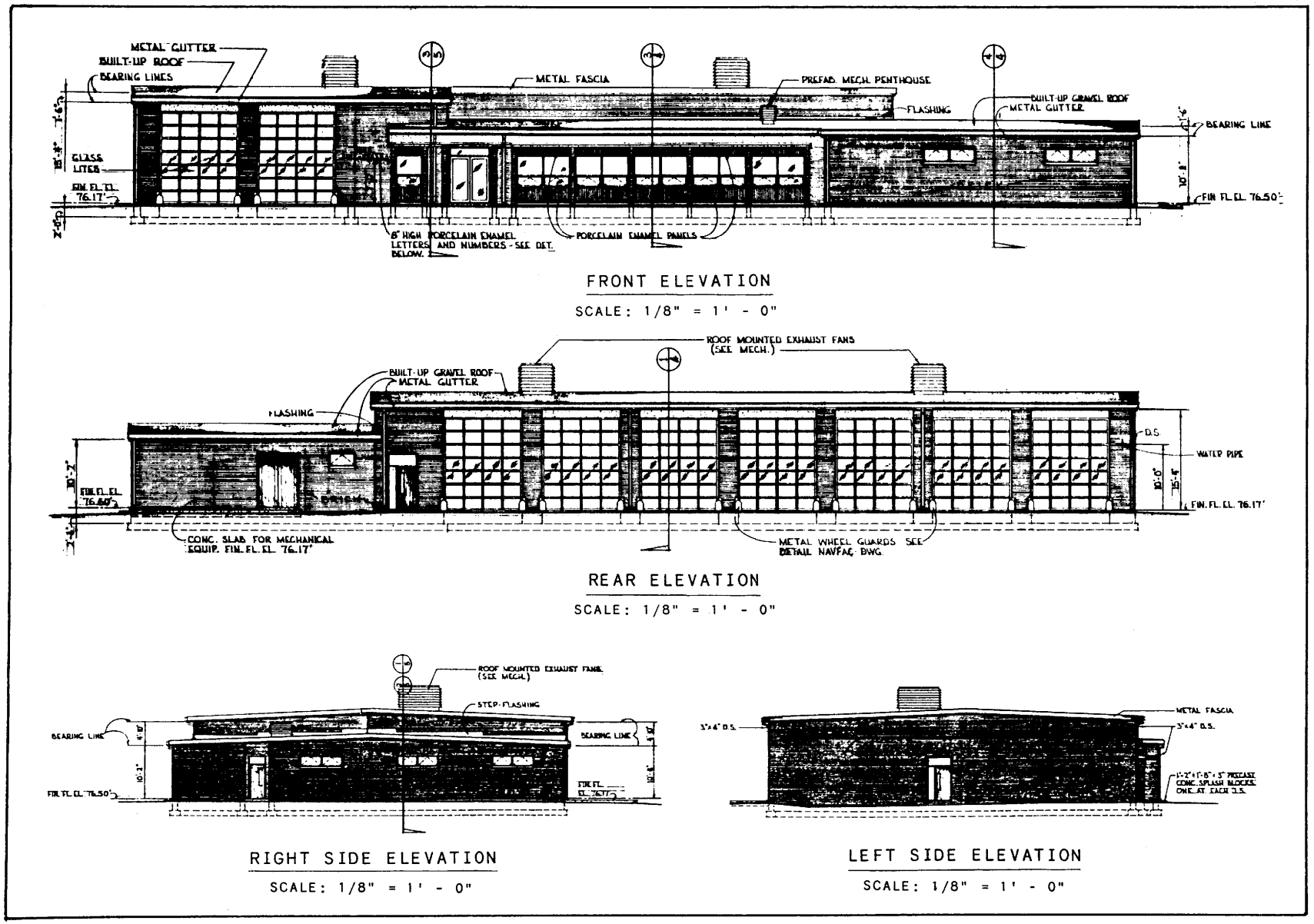

Figure 10-16.—Labeling elevations for the plan shown in figure 10-14.

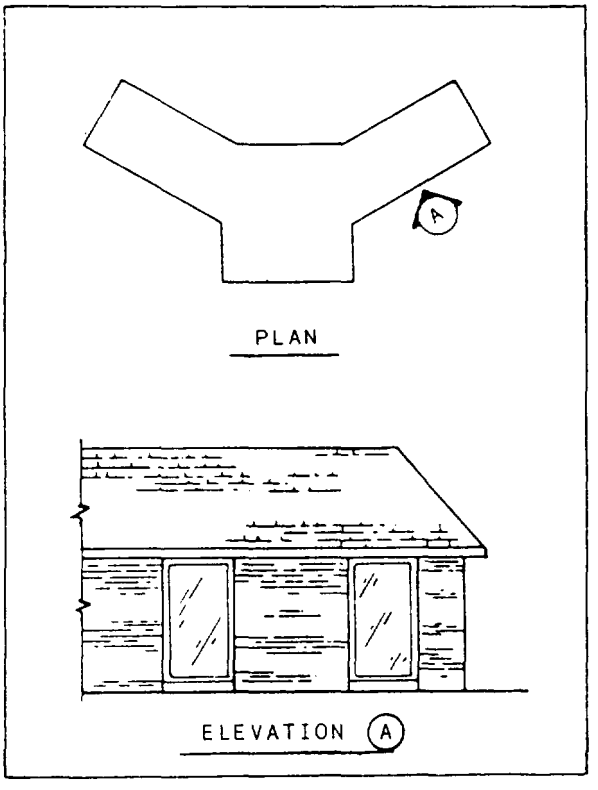

Figure 10-17.-Use of a letter to identify elevation on irregular floor plans.

irregular plans, such as shown in figure 10-17, the elevations may be identified by a letter or a number.

The following basic procedures will serve as a guide in the development and drawing of elevations:

1. Use the same sheet size as that of the floor plan. Determine the overall height and length of the elevation from the floor plan and wall section (predetermined by prior computation or a sketch). We assume that you are using the same scale for elevations as for the floor plan. Block in the views with construction lines placed in a logical order, such as starting with the front view and working around the building. Generally, the front and right-side elevations are next to each other, and the rear (if necessary) and the left-side elevations are shown below. Whenever possible, show all of the elevations on one sheet.

2. Draw the exterior limits of the elevations. The floor plan may be placed underneath the drafting sheet on which the elevations will be drawn. Vertical projections determine and define the length of exterior walls, any breaks or corners along the wall, windows, roof overhang, doors, and other elements, such as chimney location. Horizontal projections from a wall section locate the height of the doors and windows, the cave line, the bottom of fascia, the top and bottom of the footing, and the top of the roof to the space in which the elevation is to be drawn.

3. Repeat this process until all of the elevations are lightly laid out and final changes are incorporated into the exterior design. Darken the drawing, following the same procedures used in the floor plan: from left to right, top to bottom, until completed. You must remember that all of the portions drawn below the grade line are shown with a dark hidden line, and the grade line is the darkest line on the elevation drawing (disregarding the border lines).

4. Add the dimensions. Show only vertical dimensions to include the following: the bottom of the footing, all of the finished floor lines, finished ceiling lines, finished grade, height of features, chimney height, and freestanding walls. Refer to chapter 3 of this book for additional information on drafting format, conventions, and techniques.

5. Add all notes and pertinent information on exterior materials and finishes, title, scale, window identification marks, and roof pitch. Section symbols (fig. 10-6) may be shown on the elevation to indicate where the sections have been taken (fig. 10-16).

6. Finish up the elevations by adding the material symbols (fig. 10-7). Notice that symbols do not take the place of the material notations; they just supplement them. Go over your elevation checklist for completeness and accuracy of information.

STRUCTURAL DRAWINGS

STRUCTURAL DRAWINGS (sometimes identified with the designating letter *S* on their title blocks) consist of all the drawings that describe the structural members of the building and their relationship to each other. A set of structural drawings includes foundation plans and details, framing plans and details, wall sections, column and beam details, and other plans, sections, details, and schedules necessary to describe the structural components of the building or structure. The general notes in the structural drawings should also include, when applicable, roof, floor, wind, seismic, and other loads, allowable soil pressure or pile bearing capacity, and allowable stresses of all material used in the design.

Foundation Plan

A FOUNDATION PLAN is a top view of the footings or foundation walls, showing their area and their location by distances between center lines and by distances from reference lines or boundary lines. Actually, it is a horizontal section view cut through the walls of the foundation showing beams, girders, piers or columns, and openings, along with dimensions and internal composition.

The foundation plan is used primarily by the building crew who will construct the foundation of the proposed structure. In most SEABEE construction, foundations are built with concrete-masonry units and cast-in-place concrete. Figure 10-18 shows a plan view of a structure as it would look if projected into a horizontal plane that passes through the structure slightly below the level of the top of the foundation wall. The plan shows that the main foundation will consist of 12-in. concrete-masonry unit (CMU) walls measuring 28 ft lengthwise and 22 ft crosswise. In this plan, the CMU walls are identified by the standard symbol for concrete block. Ideally, a specific note should be added to call out the material.

A girder running through the center of the building will be supported at the ends by two 4-by 12-in. concrete pilasters that will butt against the end foundation walls. Intermediate support for the girder will be provided by two 12-by 12-in. concrete piers, each supported on 18- by 18-in. spread footings, 10 in. deep. The dotted lines around the foundation walls indicate that these walls will also rest on spread footings.

You need relative information about the total concept of the structure before you can draw the foundation plan. You must make a careful study of the materials and construction methods used, observe the type of foundation used, and analyze the relative position of the framing and the foundation wall or footing. You must also make reference to all of the applicable wall sections and typical sill details found in your texts and reference materials, such as the Architectural *Graphics Standards* before you start the foundation plan.

In most drafting practices, it is customary to use the ground floor plan to develop the

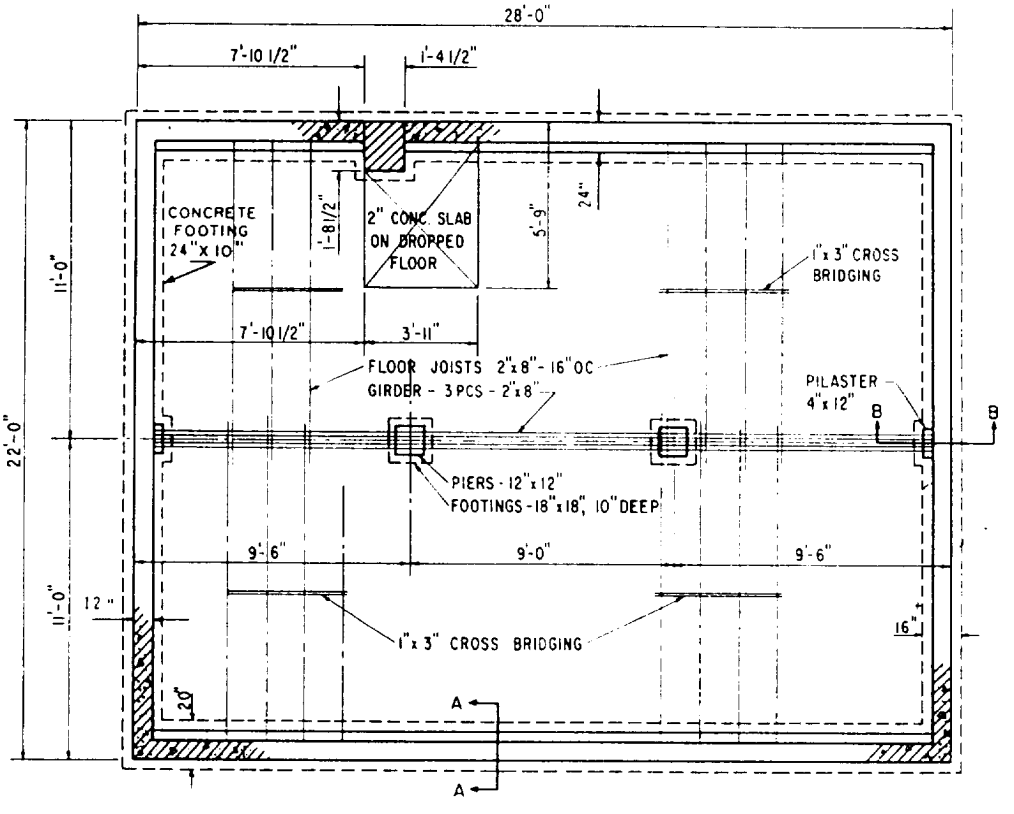

Figure 10-18.-Example of a foundation plan.

foundation plan because the floor plan readily offers the information you need for the foundation plan, such as the general shape of the building, openings, dimensions, and so forth. Some of the basic procedures in the proper development of a foundation plan are outlined below.

1. Prepare and organize your drafting needs. Since the foundation plan is usually drawn at the same scale as the floor plan (1/4 in. = 1 ft), use the same sheet size and layout. A smaller scale (1/8 in. = 1 ft) may be used for the foundation plan when it is necessary to save space and provided that the amount of information given on this plan is limited. From an EA's point of view, drawing the foundation plan at the same scale as the floor plan is easier because you can use the floor plan to trace the outline and other features, thus saving time and effort. Ideally, centering the plan would provide more space for notes and details on footings.

2. Lay out the drafting sheet lightly, beginning with the borders and title block. Tape the original, or preferably a print of the floor plan, under the sheet for the foundation plan if the same scale is being used. Draw the exterior outline of the foundation wall (usually the outside line of the exterior lines of the building), and also locate any retaining walls, steps, porches, and fireplaces. Again, be careful to notice what type of frame construction is used. The extent of using the floor plan in laying out the foundation plan varies among wood-frame, masonry, and steel-frame construction. Study these differences closely. Most often, dimensions are modified on the foundation plan, depending on the materials used. If the foundation is not drawn to the same scale as the floor plan, first determine the size of the foundation plan to be drawn, and lay it out on the sheet. Follow up by transferring all of the dimensions from the floor plan to the foundation plan. Locate other features accurately.

3. Draw the inside wall of the foundation wall once the wall thickness is scaled and the outside foundation line is located. Along the wall, locate other features, such as access doors, vents, and pilasters. Also, draw the foundation for piers, columns, chimney, and retaining wall, if required.

4. Lay out the footings. Check the standards for typical details on different types of footing and the minimum allowable footing size. Now, draw and note any additional structural information required. In wood-frame construction, the structural information for the first-floor construction is commonly shown on the foundation plan. If required, locate and lay in the supporting beam or girder and the size, spacing, and direction of floor joists.

5. Lay out the dimensions. As in all of the EA work, be sure to double-check all of the dimensions to be certain they are correct and complete and that all of the features required are located in the drawing. Apply the principals and correct drafting techniques learned from chapter 3 of this book. Add all of the notes, materials, appropriate plan symbols, and other pertinent information required to complete the plan.

6. Draw in the scale to the plan and the title of the drawing. Go over your foundation-plan checklist, and make sure the entire drawing is darkened in and labeled.

Framing Plan

FRAMING PLANS show the size, number, and location of the structural members (steel or wood) in the building framework. Separate framing plans may be drawn for the floors, the walls, and the roof.

The FLOOR FRAMING PLAN must specify the sizes and spacing of joists, girders, and columns used to support the floor. Detail drawings must be added, if necessary, to show the methods of anchoring joists and girders to the columns and foundation walls or footings.

The floor framing plan is basically a plan view showing the layout of the girders and joists. Figure 10-19 shows the manner of presenting floor framing plans. The unbroken double-line symbol indicates joists. Joist symbols are drawn in the position they will occupy in the completed building. Double framing around openings and beneath bathroom fixtures is shown where used. Bridging is also shown by a double-line symbol that runs perpendicularly to the joist. In the figure, the number of rows of cross bridging is controlled by the span of the joist; the rows should not be placed more than 7 or 8 ft apart. Hence, a 14-ft span may need only one row of bridging, but a 16-ft span needs two rows.

Dimensions need not be given between joists. Such information is given along with notes. For example, "2" by 8" joists @ 2' – 0" O.C." indicates that the joists are to be spaced at intervals of 2 ft 0 in. on center (O.C.). Lengths may not be indicated in framing plans; the overall building dimensions and the dimensions for each bay or distances between columns or posts provide such data. Notes also identify floor openings, bridging, and girts or plates.

The WALL FRAMING PLANS show the location and method of framing openings and ceiling heights so that studs and posts can be cut.

The ROOF FRAMING PLANS show the construction of the rafters used to span the building and support the roof. The size, spacing, roof slope, and all of the details are also shown in the plan. The roof framing plan is drawn in the same manner as the floor framing plan; rafters are shown in the same manner as joists. Figure 10-20 is an example of a roof framing plan for a wood-frame roof.

In a precast or cast-in-place concrete floor and roof framing, a structural plan should indicate, with symbols, the location of bearing walls, beams, and columns, and the direction and size of steel reinforcing bars, the direction of the span, and the size and thickness of required structural members. Figure 10-21 shows an example of a structural roof framing with schedules and general notes included.

When preparing framing plans, follow the procedures outlined below.

1. For wood-frame construction, trace or transfer the dimensions of the location of the exterior stud wall, and lay out the limits of the roof overhang. Next, lay out the roof framing by locating the ridgeboard first and then all of the required intersecting pieces.

2. When the floor framing plans are required, proceed to transfer dimensions of the foundation walls or footings. Lay out supporting girders and joists in their proper spacing. Notice any bearing wails, stairwells, and other openings when you are developing a second-floor framing plan.

3. For concrete framing, take a similar approach. Lay out the dimensions of the bearing walls below the floor (or roof) being framed. Hence, you will need the foundation plan to draw the first-floor framing, and you will need the first-floor plan to draw the second-floor framing. Next, add the locations of the beams and columns and the direction of the span and size of the precast concrete or the reinforcing steel for the poured-in-place concrete.

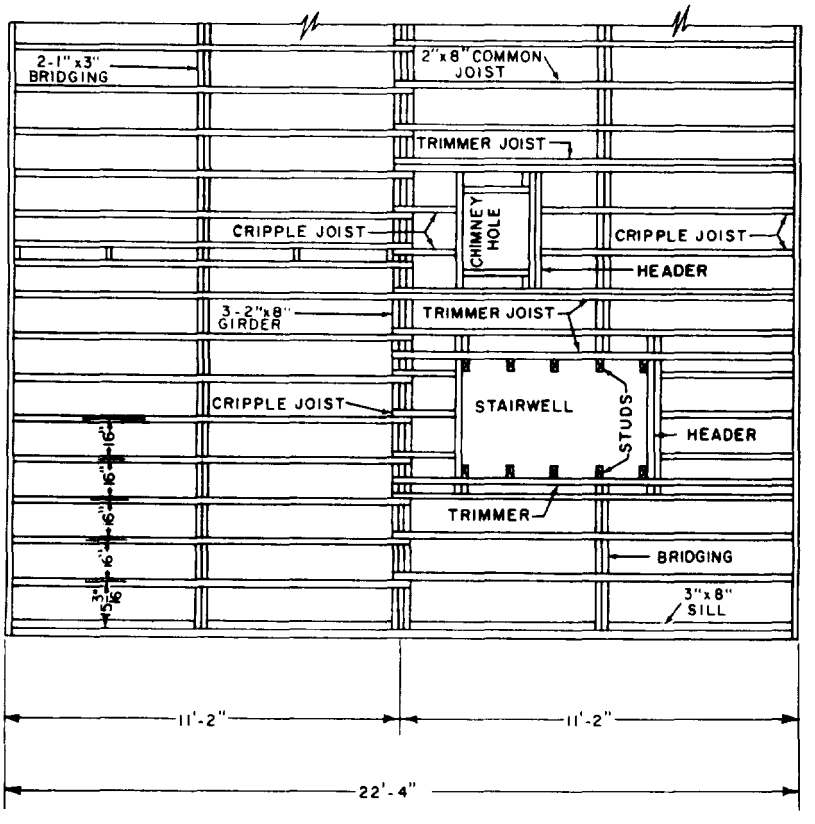

Figure 10-19.-Example of a structural floor framing plan for a wood-frame construction.

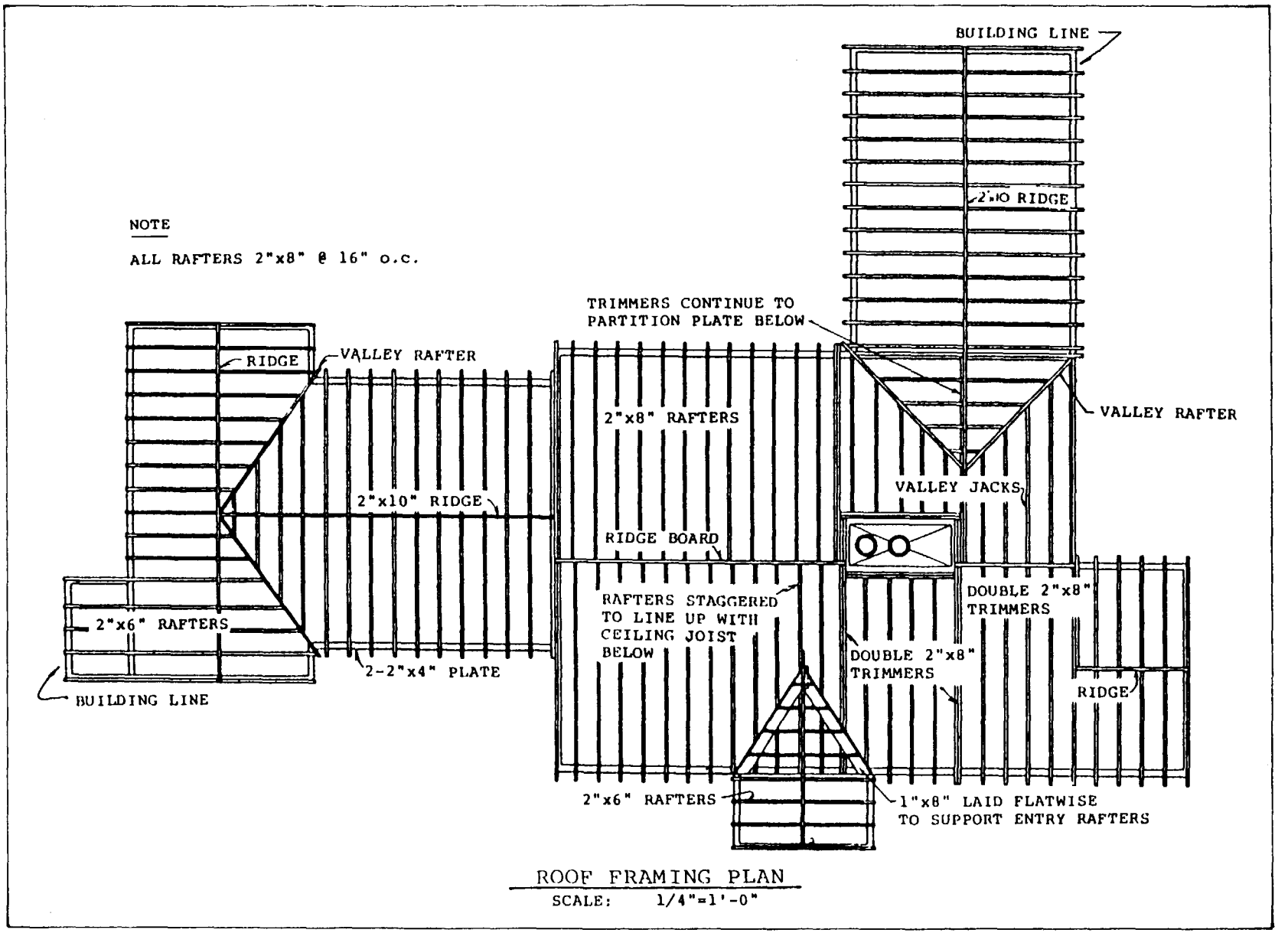

Figure 10-20.—Typical structural roof framing plan for a wood-frame construction.

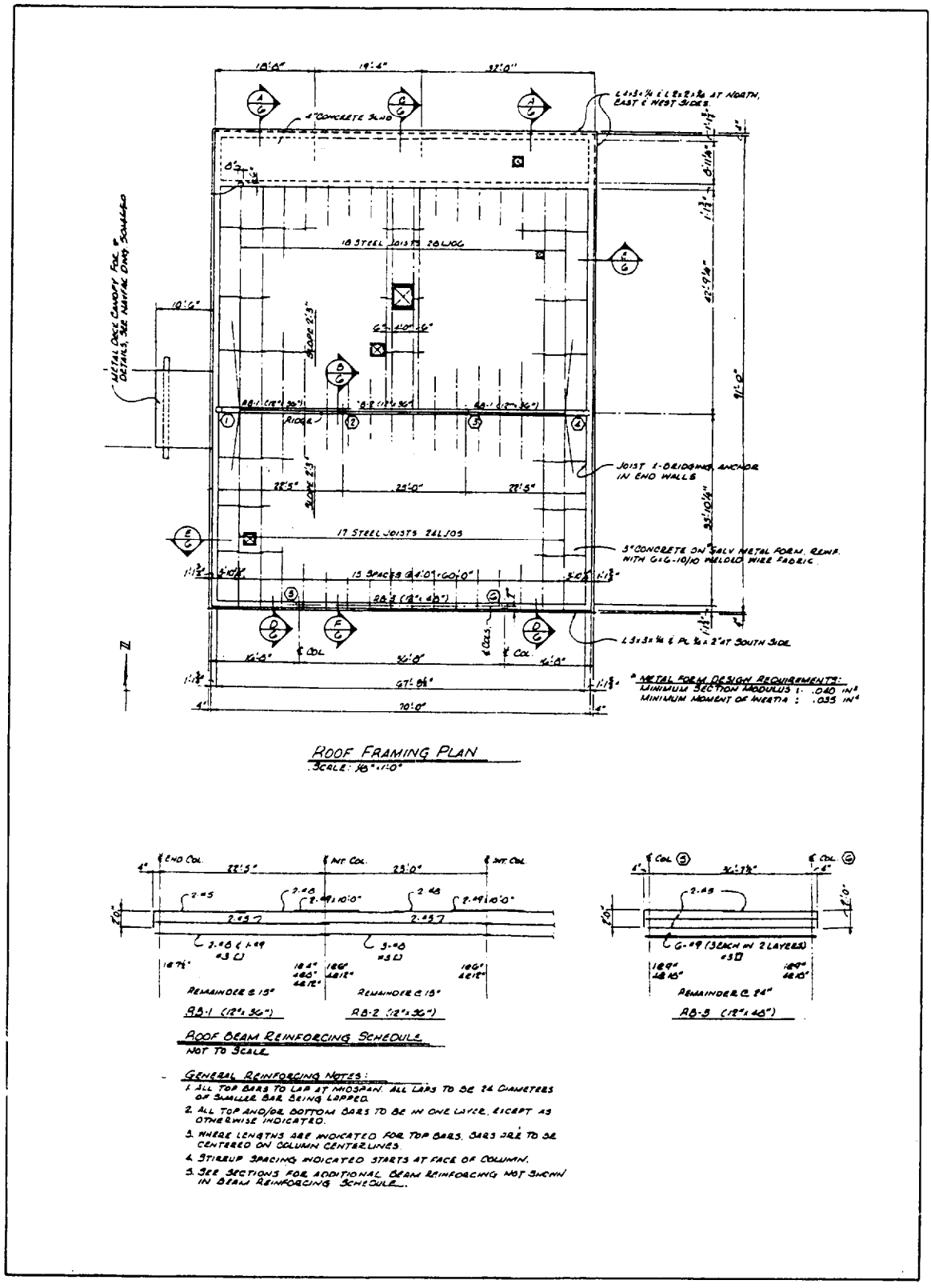

Figure 10-21.-Example of a structural roof framing plan for a precast or a cast-in-place concrete construction.

4. For steel framing, trace off or transfer the dimensions of all of the bearing walls, columns, and beams below the floor (or roof) being framed. Lay out the steel framing, using the grid system (a common setup used in steel framing).

5. Lay out guidelines for dimensions, notes, and labels. Darken in all of the framing and fill in the notes and dimensions. Draw in the section and detail marks. Go over your structural plans checklist and check the dimensions against those traced from the floor plan.

MECHANICAL DRAWINGS

Refer to chapter 8 of this book to review the basic functions of the components associated with the mechanical systems and the methods used in the development of a mechanical plan. This section will focus on the procedures applicable in drawing plumbing plans for residential and commercial buildings.

In some residences and commercial structures, a separate mechanical plan is drawn to show fixtures, water supply and waste disposal lines, equipment, and other supply and disposal sources. In drawing a plumbing plan, the following procedures apply:

1. Trace the floor plan, showing all exterior and interior walls, major appliances, and plumbing fixtures. Orient your drawing so that enough space is left for fixture schedules, legends, details, or other related information. Note that the outline of the building is drawn in thin but visible lines.

2. Draw the water-supply line from the source into the house, and then, one by one, to all of the fixtures. Use the appropriate line thickness and symbols for drawing valves, fittings, and pipe sizes. Next, draw the disposal system. Start the layout with the house or building drain from just outside the building. Also, locate the waste and vent stack at this time.

3. Add a symbol legend, drawing title, notes, and scales, and fill in the title block. Go over and double-check the dimensions and the checklist.

As you can readily tell from figure 8-27 in chapter 8, plumbing plans alone can become extremely difficult to read and fully comprehend. For this reason, it is general practice to prepare and include riser diagrams, such as those shown in chapter 8, figures 8-24 through 8-26. These isometric drawings are much easier to understand and are invaluable to those responsible for preparing material estimates and to the craftsmen (UTs) responsible for installing plumbing systems.

As alluded to in chapter 8, the mechanical division of a set of construction drawings will include, in addition to plumbing plans and details, drawings for any heating, ventilation, and air-conditioning systems that a building might contain. Frequently, the drawing sheets in the mechanical division are identified by the designating letter *M* in the title block. However, remember that in the order of drawings, these sheets containing heating, ventilation, and air-conditioning drawings will precede those for plumbing.

ELECTRICAL DRAWINGS

The electrical systems and plans, as described in chapter 9, consist of the basic functions of the components associated with electrical distribution and interior wiring and the methods used in the development of an electrical plan. This section, however, emphasizes the procedures used in preparing an electrical drawing or plan. It is important for an EA not only to understand the symbols and drafting methods used here, but also to learn a great deal about how the system works, the safety of the system, and the minimum requirements of local and national codes included in the drawing. The drawing sheets in the electrical division of construction drawings are frequently identified by the letter *E* in their title blocks.

In drawing the electrical plan, follow the same approach used in the mechanical drawing, such as using the correct line thickness and proper orientation. To the fullest extent possible, be sure, also, to use the standard electrical symbols discussed previously in the text.

1. After the floor plan is traced, locate the meter and service panel, noting the voltage rating and the amperage. Locate all of the convenience outlets, ceiling and wall fixtures, and other electrical devices required with the appropriate symbols.

2. Locate all of the switches; connect the switches to the fixtures or convenience outlets,

using a template or a french curve. The curved lines may be solid or dashed, and should be included in the symbols list. Add the circuits, the circuit numbers, and the circuit notations.

3. Next, add a symbol legend and a fixture legend (if required). Place the drawing title, note the scale, and fill in the title block. Again, go over your drawing for completeness and accuracy.

SECTIONS

As necessary, SECTIONS are used in each of the main divisions of construction drawings to show the types of construction required, the types of materials used, their locations, and the method of assembling the building parts. Although they may be used in each of the divisions, the most common sections are generally located in the architectural and structural divisions.

All properly prepared sections are important to those responsible for constructing a building. Perhaps the most important of all are WALL SECTIONS, such as those shown in figure 10-22. These sections, commonly drawn at a scale of 3/4 in. = 1 ft, and normally located in the structural division, provide a wealth of information that is necessary to understand the structural

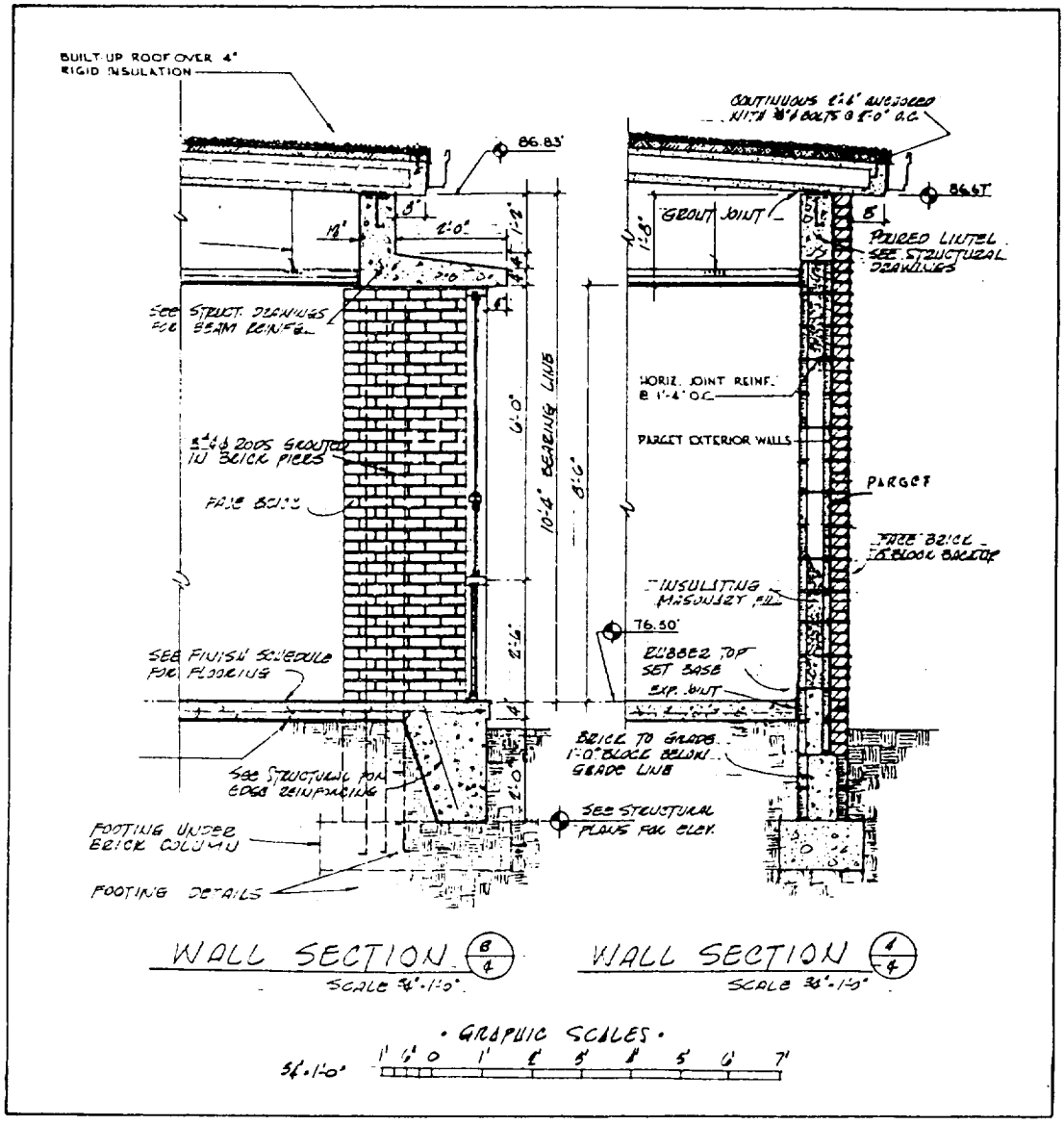

Figure 10-22.-Examples of wall sections.

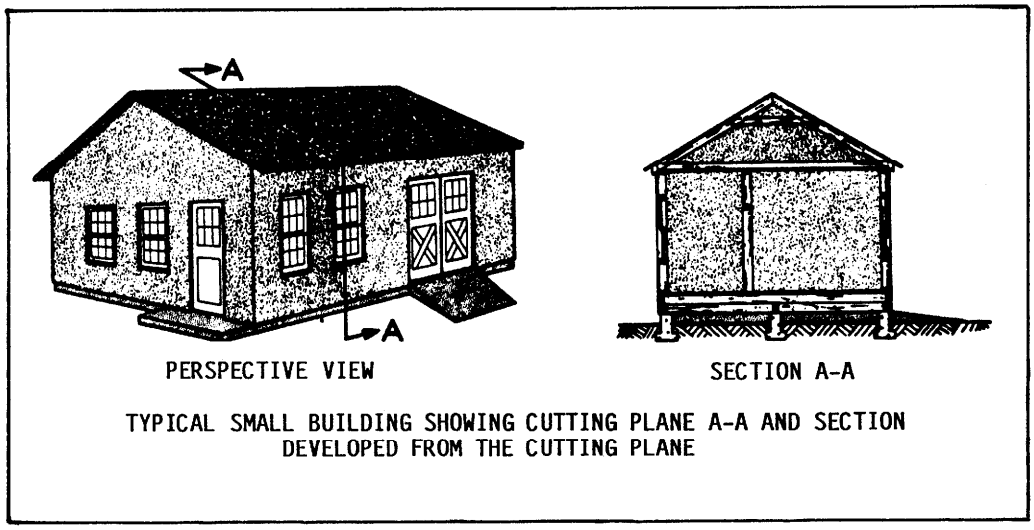

Figure 10-23.—Development of a sectional view.

arrangement, construction methods, and material composition of the walls of the building.

When a cutting plane is passed through the narrow width of a building, as shown in figure 10-23, a TRANSVERSE, or CROSSSECTION, is developed. Similarly, passing the cutting plane through the length of a building results in a LONGITUDINAL SECTION. These section, usually located in the architectural division, are used to clarify the building design and total construction process. Another example of a building section is shown in figure 10-24, view A. Often, transverse and longitudinal sections are drawn at the same scale as the floor plan. To show as much construction information as possible, it is not uncommon for staggered (offset) cutting planes to be used in developing these sections.

If the time and effort were spent to draw a separate section for each and every wall and part of a building, it would soon become apparent that many of these sections are completely identical. To reduce the time and effort required for drafting and to simplify the construction drawings, it is common practice to use typical sections where exact duplications would otherwise occur. An example of a typical section is shown in figure 10-24, view B.

For best results and to save time, you should make a sketch of the section before beginning the actual drawing. Always have your sketch checked by your leading petty officer or another experienced EA to make sure that your work is compatible with their concept of the design of the building.

When more than one section is placed on the drafting sheet, arrange the sections so that the first one is through the front of the building, the other sections, excluding the last, move progressively through the interior, and the last one is through the back. This way, when the sections are finished, they give the user an orderly construction "tour" through the building. The following procedures will guide you in the development of a section:

1. After having selected the appropriate scale, lay out the first section lightly. Next, lay out all the other sections, allowing enough space between them for notes and dimensions. Align the sections so that the same elevation is maintained and the sections relate to one another, as shown in figure 10-22. Again, maintain enough clearance for subtitles and scale and enough room for your title block.

2. Lay out the guidelines for the material labels, leaders, and vertical dimensions.

3. Darken the section drawings, using a system such as starting at the top of the sheet and working down, then starting at the left and

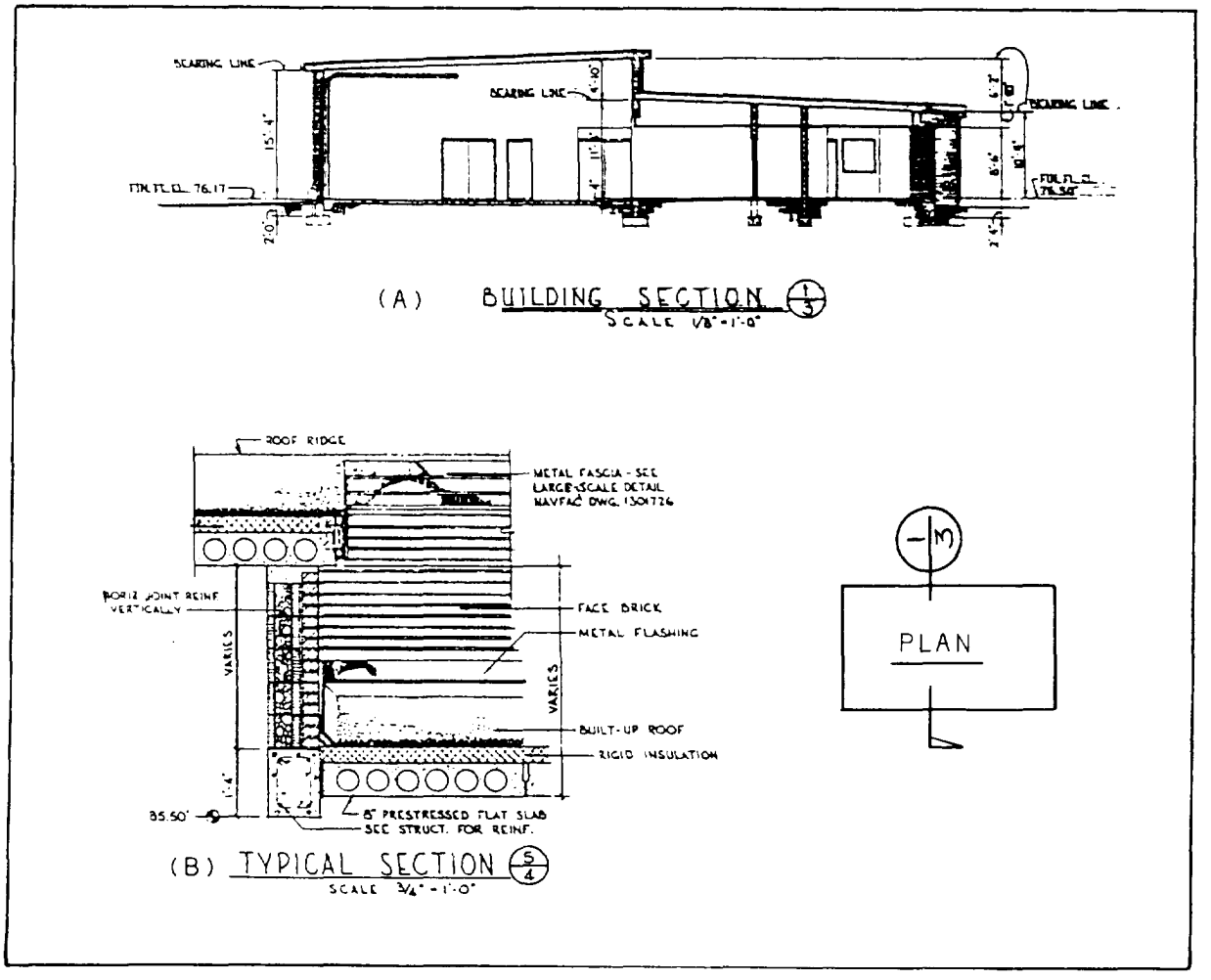

Figure 10-24.-Types of sections.

working to the right until completed. Next, put in all of the labels, notes, and dimensions. You may add detail markings, if any, at this time.

4. Add material symbols. Some EAs prefer to place the symbols at the back of the sheet rather than in the front for neatness and fast access for erasure when a minor change or revision affects them. Place the title and scale below to complete the section drawing. Remember to go over your section checklist for accuracy and completeness.

DETAILS

DETAILS are large-scale drawings of the construction assemblies and installation that were not clearly shown in the sections. These enlarged drawings show the user how the various parts of the structure are to be connected and placed. The construction of specific types of foundations, doors, windows, cornices, and so forth, are customarily shown in detail drawings located within their applicable main division of the construction drawings. Details are usually

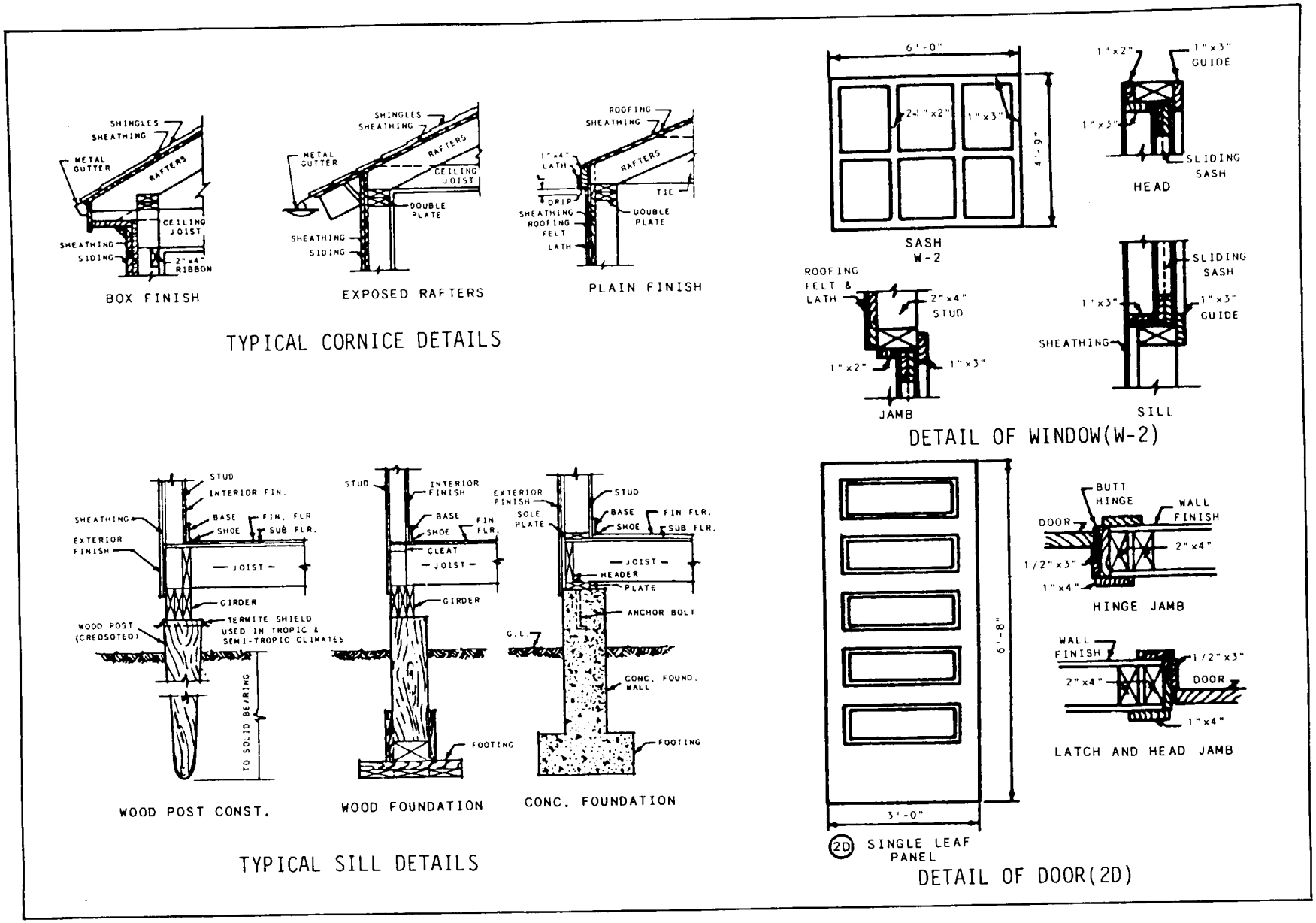

Figure 10-25.—Examples of detail groupings.

grouped (fig. 10-25) so that references may be made more easily from the general drawing.

The scale selected for details depends on how large it needs to be drawn to clearly explain the required information. Details are usually drawn at a larger scale than the sections, generally 1 in., 1 1/2 in., or 3 in. = 1 ft.

Details commonly used for installation of items such as doorframes and window frames, fireproofing, and material connections are readily available in the *Graphic Standards* and Sweet's catalogs. These typical details, however, are to be adapted to the particular building being drawn. You may avoid the use of "typical" details when different conditions actually exist. It is important for an EA to understand construction well enough to make an accurate detail drawing.

Selecting the particular sheet to draw the detail is important. Details that relate to the drawing are placed on that sheet; if space is limited, all other details should be placed with the section or schedules or on a separate sheet set aside for details. Likewise, door details should be placed on the sheet with the floor plans, on the sheet with the door schedule, on a sheet with sections, or on a sheet set aside for details.

The following procedures are given to guide you in the development and drawing of details:

1. Lay out the details on the particular sheet. Draw extension lines, dimensions lines, and guidelines for all of the dimensions lightly.

2. Darken in the details, one at a time, using a system similar to that used in drawing sections. Add labels, notes, and dimensions. Remember to show all of the sizes and thicknesses of materials required.

3. Add material symbols and place title and scale below the detail to complete the drawing.

SCHEDULES

SCHEDULES are tabular or graphic arrangements of extensive information or notes related to construction materials. The use of schedules presents a quick and easy way for planners, estimators, contractors, and suppliers to share similar data, hence reducing construction errors and saving time. In the SEABEEs, the success of the planners and estimators (P&E) in accurately preparing takeoff, of the supply department (S-4) in properly ordering construction materials, and of the construction crew (line companies and detachments) in installing the materials in their proper locations depends greatly upon the efficiency with which the relative information is conveyed on the drawing (plans).

The material information most commonly placed in schedules relates to doors, windows, room finishes, lintels, and other structural elements. The information required on a DOOR SCHEDULE varies from a bare minimum (for small jobs) to extensive (for large projects). A door schedule may include the following: door number, quantity, mark or code number, type, size, material description, lintel, and remarks.

An example of a tabular door schedule is shown in figure 10-26. Doors are commonly

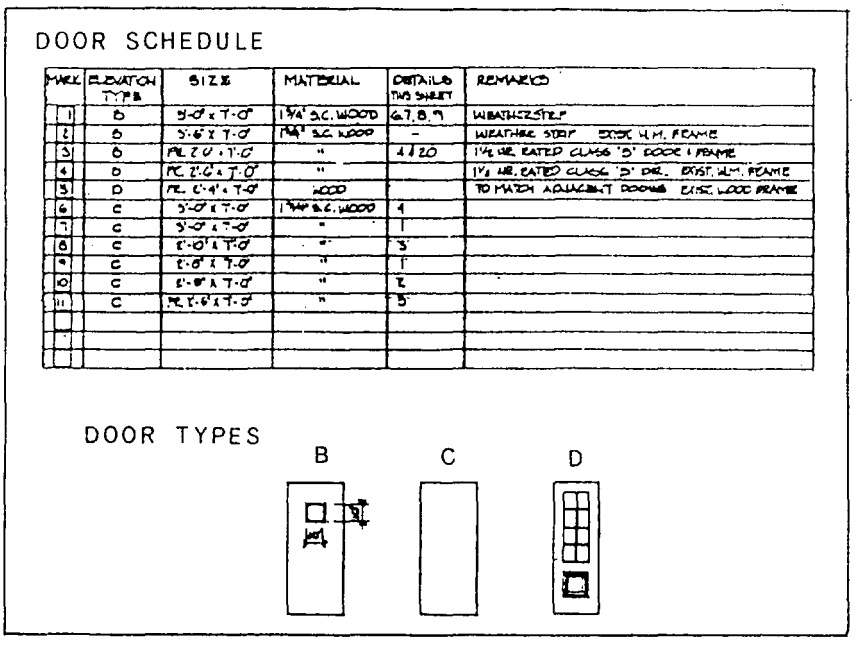

Figure 10-26.-Example of a door schedule.

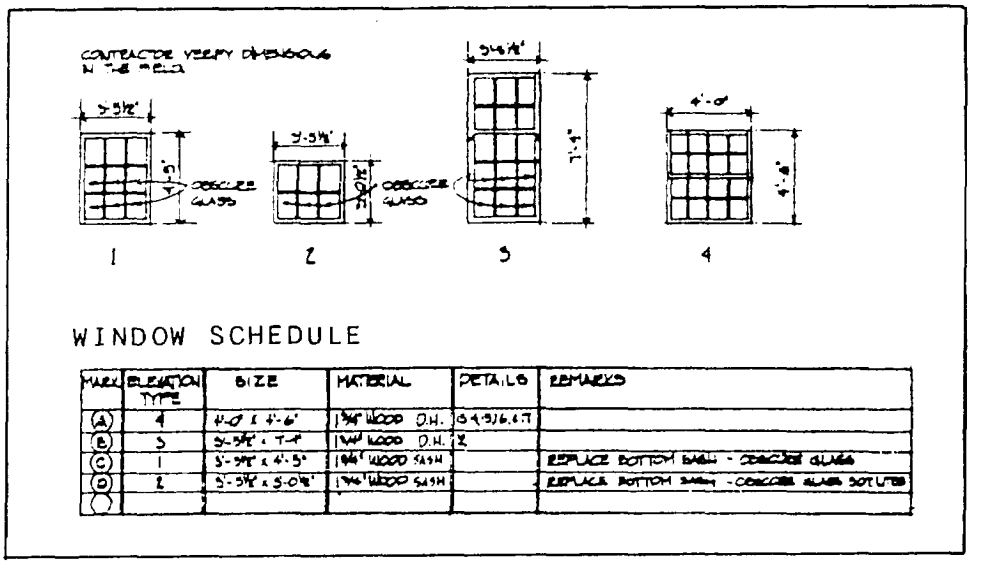

Figure 10-27.-Example of a window schedule.

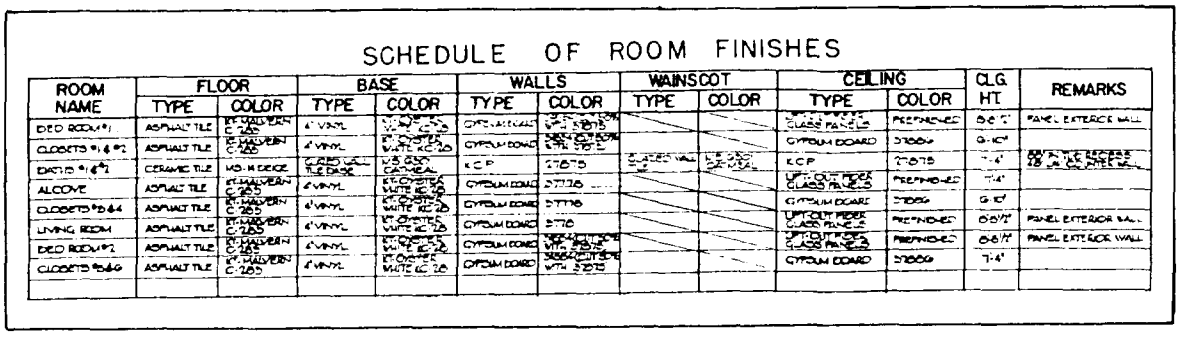

Figure 10-28.-Example of a material finish schedule.

marked with a number or numbers and letters. Letter *D* is a common designation used for doors (sometimes enclosed in a circle or other shape). A WINDOW SCHEDULE (fig. 10-27) provides an organized presentation of the significant window characteristics. Information often includes the following: mark, window type, size, required opening size, material type, lintels, and remarks. Windows are often marked with letters or letters with numbers. Letter *W* is used most commonly for window schedules. A MATERIAL FINISH SCHEDULE (fig. 10-28) may include the following: room number, material finish for floors, walls, base, and remarks. Where several rooms in a row have identical finish, a common practice is to use the ditto mark (˝) or initials DO. It is essential that you take care when making changes in the material finish used in a particular room, as changes you make will greatly affect other rooms below it. Errors are less likely to occur and revisions will be easier to handle when each space in the schedule is lettered individually. Remember, whenever possible, place all of the schedules on the same sheet as their respective drawings on the building.

BILL OF MATERIALS

A BILL OF MATERIALS (BM) is a tabular statement of material requirements for a given project. It contains information, such as stock numbers, unit of issue, quantity, line item

number, description, vendor, and cost. Sometimes the bill of materials will be submitted on material estimate sheets or material takeoff sheets, but all will contain similar information. Actually, a bill of materials is a grouped compilation based on takeoffs and estimates of all of the material needed to complete a structure. The takeoff sheet usually is an actual tally and checkoff of the items shown, noted, or specified on the construction drawings and specifications.

In most cases, each NAVFACENGCOM drawing contains a separate BM; however, sometimes an in-house project prepared by local commands may contain a BM incorporated within the set of drawings. Figure 10-29 shows an example of a completed BM.

BILL OF MATERIAL (NAVFAC-DBC-4813/2 (2-75)) 0900-LL-P81-3020

PROJECT: INTERIM WATER SYSTEM REINDEER STATION (CANTONMENT AREA)

SHIP APRIL 19-

BM NO. DIW 112

AUTHORITY

PAGE OF

ROUT IDENT	M&S	SERV & REGMT	O&D	SERV & SUPP ADDRESS	SIG	FUND CODE	PROJECT	PRI	RDD	JOB ORDER	ACCOUNTING DATA	ROS
P96	2	N62583	N	Y1W112	A	TNW	ZM9	05	094	4K6404		

DOC IDENT	FSC	STOCK NUMBER NIIN	UNIT OF ISSUE	QUANTITY	DOCUMENT NUMBER DATE SERIAL	COG	ADV	L/T	CRIT FLAG	DESCRIPTION/SPECIFICATION/VENDORS	UNIT COST	TOTAL COST	LOCATION	QTY/DATE RECD	QTY/DATE ISSUED
ADE			SH	69	40817903			1		PLYWOOD, 3/4"X4'X8' BB EXTERIOR TYPE. SUGGESTED VENDOR: THOMPSON LUMBER CO.	12.00	828.00			
			BF	30	7904			2		LUMBER, SOFTWOOD, 1"X6"X12' STANDARD CONSTRUCTION GRADE 2 OR BETTER. SUGGESTED VENDOR: THOMPSON LUMBER CO.	.18	5.40			
			BF	2422	7905			3		LUMBER, SOFTWOOD, 2"X4"X16' STANDARD CONSTRUCTION GRADE 2 OR BETTER. SUGGESTED VENDOR: THOMPSON LUMBER CO.	.28	678.16			
			BF	144	7906			4		LUMBER, SOFTWOOD, 2"X6"X16' STANDARD CONSTRUCTION GRADE 2 OR BETTER. SUGGESTED VENDOR: THOMPSON LUMBER CO.	.28	40.32			
			BF	1173	7907			5		LUMBER, SOFTWOOD, 4"X 4"X 16' STANDARD CONSTRUCTION GRADE 2 OR BETTER. SUGGESTED VENDOR: THOMPSON LUMBER CO.	.33	387.09			

SUBMITTED BY	DATE	APPROVED BY	DATE	TARGET APPROVED BY	DATE	BM TOTAL LINE ITEMS	PAGE TOTAL $	BM TOTAL $
E.B. JASON	20 MAR	T.J. ABERNATHY	3-25-				1938.97	

Figure 10-29.-Example of a bill of materials prepared locally.